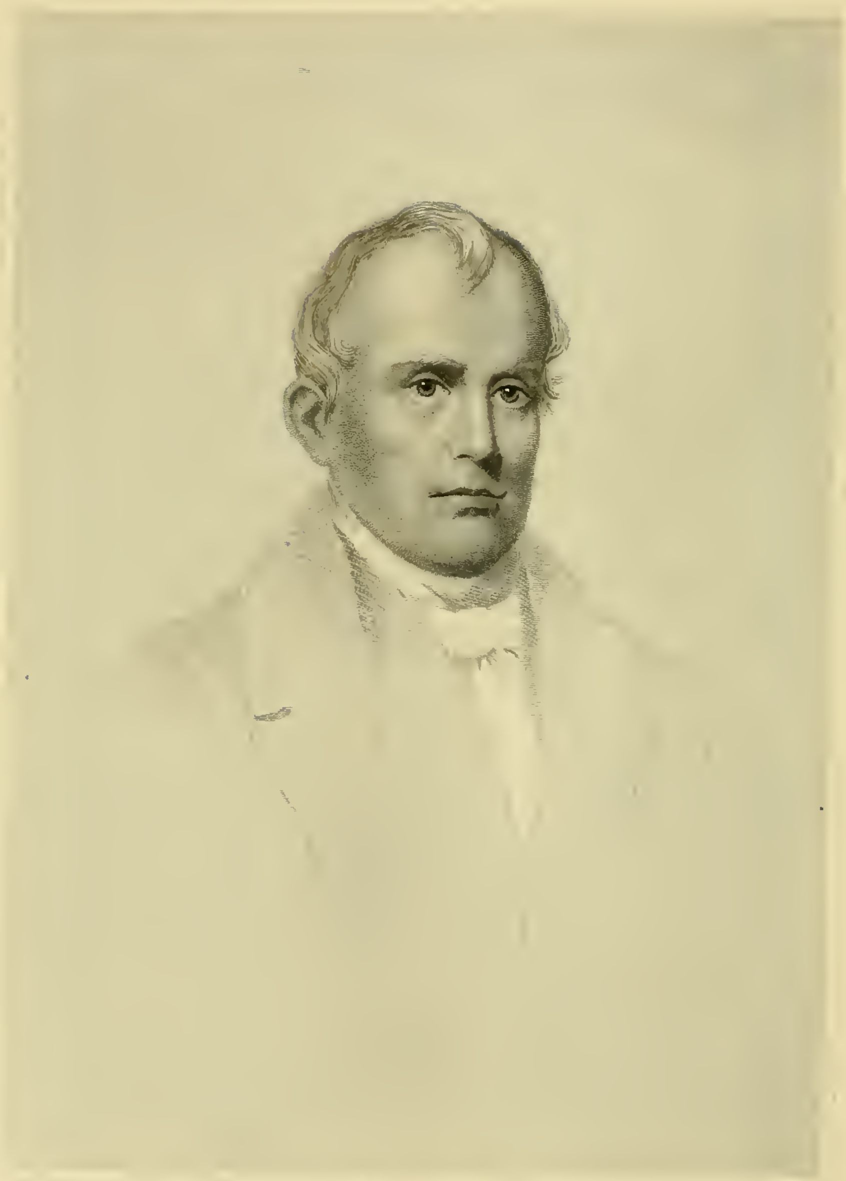

LAMB'S

TEXTILE INDUSTRIES

OF THE

UNITED STATES

EMBRACING BIOGRAPHICAL SKETCHES OF PROMINENT MEN AND A HISTORICAL RESUMÉ OF THE PROGRESS OF TEXTILE MANUFACTURE FROM THE EARLIEST RECORDS TO THE PRESENT TIME

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INTRODUCTION

IN THE early stages of the history of the modern world, the strongest and richest nations were the best fighters,—those who could wrest from others what they needed, whether of food or clothing, or shelter: the capital of a nation was the brawn and muscle of her warriors. This was the age of destruction, otherwise, the heroic age. But men tired of constant warfare; having won riches, they craved ease. A new era dawned, and heralded a softer and a wider civilization,—the age of construction. Cathedrals and palaces were built, art in her thousand forms awoke, men painted, and sang and wrote. Then came Caxton, the maker of books; men read and thought; and thought gave birth to invention. The limitless possibilities of the minds of men, as they studied the organic principles of form and motion and applied them to their uses, ushered in a new age,—the age of production.

The history of human endeavor in the early stages of manufacturing reads like an Eastern fairy tale, when the Sons of Industry awoke the Geni of Machinery and compelled him to do their bidding. The story is human, too, and though told in the tersest way, one may read between the lines a history of the heart; of courage in the face of difficulties, of patient perseverance in spite of all obstacles, of self-denial, and even of privations cheerfully borne in order that the object in view might be accomplished. So, one by one, were the marvels of textile machinery wrought with patient endeavor by those who are among the great benefactors of mankind. The capital of each nation lies now in her industries, in the brawn and muscle of her workers, not of her fighters.

The industries of a nation may be listed under two categories; those which furnish luxuries, and those which are essentially necessary. While the first may be productive of immense wealth, may furnish employment to a great number of

persons, and so in a measure be essential to the well-being and prosperity of a nation as a whole, the second are absolutely indispensable to the life and integrity of the state; for, lacking them, in great internal crises, nations would be dependent on foreign countries for their supplies of common necessaries.

First under the head of the latter must be noted the textile industries, as being of vast importance in all civilized countries. In fact, the amount of the textile manufactures of a country would appear to be a criterion of its prosperity. Spain, in her period of decadence, has witnessed the declination of the spinning and weaving industries which had made her a powerful and wealthy nation under the Moors and under the first Catholic kings; Japan, on the other hand, which is marching with giant strides toward the highest civilization, realizes that in order to keep pace with modern progress she must look to her manufactures and follow the example of the United States and Europe, and of India, also, we may add, in augmenting her textile industries.

At the head of the textile manufactures of the world we must place cotton, as much for its diversity of production as for its amount; for no one article of manufacture so dominates the prosperity of the world at large as does the product of the wonderful plant gossypium. For this reason the initial volumes of this series are devoted to cotton, as being by far the most important of all textile industries, especially to the United States, which provides over sixty-nine per cent of the raw material consumed throughout the entire world in the cotton industry.

At the outset it was the intention of the publishers to condense within the narrow confines of a single volume the History of the Textile Manufactures of the United States, but although they have not deviated from their purpose of presenting merely essential facts in the historical and technical articles descriptive of the progress and methods of the various branches of the industry, and in their biographical sketches of the leaders and the pioneers of the textile industries, and those in the briefest manner possible, the material so kindly and promptly sent in to them at their first request exceeded many times the limit they had set, and obliged them to define a new

policy and to provide for the publication of a number of volumes, one or more to be devoted to each particular industry in the order of its importance, as cotton, wool, silk, flax, hemp and its kindred fibres.

Innumerable books have been written regarding the kings, warriors and statesmen of the nations, setting forth in glowing colors their deeds and their triumphs, but little has been set down concerning the Great Captains of Industry, of their invincible courage and determination, and of their achievements for the welfare of mankind. People at large know almost nothing in regard to the vast importance of the industrial forces which make the prosperity of the nation. But the time has now come when the story should be told, when the people should have placed before them an authentic history of the origin and rise of the various industries which make the United States one of the most prosperous and wealthy nations of the earth.

Here are no deeds of bloodshed; no lurid flame of the havoc of war; the light upon the pages is that of a thousand forges glowing, the rythm is that of a thousand anvils ringing, as the swart workers produce, not weapons of destruction and defence, but the delicate parts of mighty machines, into which the makers have transfused, it would almost seem as one watches them at work, some of that intelligence which they themselves have received from the Great Source of All Intelligence. Here are no devastated homes, no fields laid waste, no harvests destroyed; the forces of industry have verily made the waste places to blossom, have increased the harvest a hundredfold, and filled the land with pleasant homes for the millions of patient workers.

As for the men whose ability and enterprise and capital have made all this possible, their best eulogy is the record of their lives and works, which will be found within the pages of these volumes.

The publishers and editors of this work owe a debt of gratitude as well for the words of pleasant encouragement as for the help that has been afforded them along every line by hundreds whom they have approached for information concerning the technicalities of the different industries which are treated

in the scope of this work which they now present to the public in the confident assurance that their labors will be appreciated.

The authenticity of the facts concerning both men and manufactures, as set forth in this series, has been proven beyond a doubt, it being the purpose of the publishers to produce a reliable compendium for referential purposes. To this end the most thorough researches have been made, the work of investigation having been agreeably lightened by the coöperation of all those who have been approached for information.

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THE HISTORY OF COTTON PRODUCTION

Part I—In the United States

BY DANIEL C. ROPER

The growing of cotton has entered more extensively into the building of the United States, has exercised a greater influence upon the character, the manners, the customs and the destinies of its people than that of any industry. Cotton has been grown and used for centuries in India and China, and even in Mexico and South America, but it remained for this country to give the industry its commercial importance. When the needs of a rapidly growing population demanded an increase in the supply of raw textile material, the United States, as if by the hand of destiny, began her slow but sure work in meeting this necessity with a fibre which has so amply supplemented others that, by lowering the cost, it has made it possible for the greater part of the human family to wear what otherwise must have remained only the garb of the favored.

Introduction of cotton growing.—When Christopher Columbus discovered America in 1492, he found the cotton plant growing wild, but the earliest effort to cultivate it in the United States was in 1621, in what is now the state of Virginia. The seed of the first cultivated varieties probably came from the Levant or the East Indies. It was at first planted as an experiment and for more than a century was not seriously regarded as a useful crop. Its cultivation during this period was confined to small patches for domestic uses. In fact, the culture never reached large proportions in Virginia, as the soil and climate made tobacco growing more profitable. Further experiments in cotton growing in these early days were made in Maryland, Delaware, Pennsylvania and New Jersey, but of course, the production in these localities was never large. Had the first settlements and experiments been made further south, in say, Georgia or South Carolina, where climate and soil are better suited to the plant, the development of the industry would no doubt have been more rapid. It was introduced into South Carolina about 1733. The trustees of the Georgia Grant, who received seeds from England, introduced it into Georgia in 1734. A desposition, taken in London in 1739, for the use of these trustees, declared, "The climate of Georgia is very healthy and the climate and soil are very fit for raising silk, wine, and cotton, all of which products can be raised without the aid of negroes." Subsequent

history did not bear out this assertion so far as labor is concerned. Labor was scarce and expensive and the tedious process of separating the seed from the fibre cost more than the lint was worth in the market. To provide the necessary quantity of cheap labor to cultivate, harvest and clean the crops, importations of slaves into the cotton growing districts were made, and from that time forth cotton growing and slavery sustained and fostered each other. Cotton was grown in Louisiana as early as 1741, for in that year, Dubreuil of that locality invented a machine for separating the seed from the lint, which wonderfully stimulated cotton growing.

The two general species of cotton grown in the United States are upland (Gossypium Herbaceum) and sea-island (Gossypium Barbadens). (See Plate 1.)

Sea-island cotton was introduced into Georgia in 1786 by Governor Tattnall, who secured the seed from the Bahama Islands and who encouraged its cultivation along the coast of that state. To Kinsey Burden and wife, of Colleton county, South Carolina, is due the credit for its introduction into that state about 1786, and for making the careful selection of the black seed from which have come all of the best varieties now grown in the United States. The first commercial quantity was grown in 1790 by William Elliott on the ground where Jean Ribault landed his first colonists and claimed the country for France. The cultivation of this cotton is now confined to portions of South Carolina, Florida and Georgia; the superiority of the product of these states being in the order in which the states are named.

Cotton area.—The present cotton-growing region of the United States is about 1,450 miles long from east to west and about 500 miles in width, containing approximately 700,000 square miles, or about 445,000,000 acres. Of this the annual cotton-producing area amounted in 1911 to about 33,000,000 acres, which means that only one acre in every fourteen of the total is devoted to cotton.

The area in which cotton was grown in the United States in 1910 is indicated on the accompanying map. Localities producing upland cotton only are represented by horizontal lines, and those producing sea-island or both sea-island and upland cotton by barred lines. (See Plate 1.)

Development of cotton growing.—The early development of this industry was very slow, the first sample of American cotton being sent to England in 1739, or 118 years after its introduction in Virginia. Several bags were exported from Charleston in 1747, but it was not until 1753 that there was sufficient interest manifested in the industry to call forth a cotton premium. In that year a citizen of Delaware offered £4 ($20) for "the most cotton and the best cotton off one acre." The small demand for this fibre was a drawback to the culture, the market price being frequently less than the expense of growing, gathering and preparing it. There were no adequate implements for cultivating and harvesting, but the greatest obstacle was a

PLATE I—Cultivation of Cotton

1. Cultivation.
2. Cultivation.
3. Unopened Boll (Upland Cotton).
4. Mature Cotton Boll.
5. Cotton Field.
6. Cotton Plant, American Upland.
7. Cotton Plant, American Upland.
8. Sea Island Plant.
9. Asiatic Plant.
10. Area.

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scarcity of labor. The following record of shipments to Liverpool in 1770 is interesting: "Ten bales of cotton from Charleston, three bales from New York, four bags from Virginia, and three barrels from North Carolina." In 1784 some fourteen or fifteen bales were shipped to England, and eight of these were seized in Liverpool as being improperly entered, on the ground that so much cotton could not have been grown in the American Colonies. After the Revolutionary War, however, the development was more rapid, as in 1791 the United States exported the equivalent of about 400 bales, of 500 pounds each, that being but one-tenth of the crop of 1790. Three-fourths of this crop was grown in Georgia and practically all of the balance in South Carolina.

The later development of the industry was greatly fostered by a better understanding of the culture; that "how to do, comes of doing" was found true here. Implements for use in planting and cultivating rapidly improved. The "roller gin" has already been mentioned, and improved forms of this are still used for sea-island cotton, but the invention of the saw-gin for upland cotton, commonly credited to Eli Whitney, marks the most important epoch in the history of cotton culture. From the invention of this gin in 1793, the industry advanced very rapidly. Two years later the effectiveness of the saw-gin was wonderfully increased by the success of Mr. James Kincaid, a resident of the district now known as Fairfield county, South Carolina, in applying water power to the operation of the gin. Later the application of steam power and the invention of improved presses for baling the lint were helpful factors. As slavery had had much to do with the development of the production of cotton, it was only natural that the abolition of slavery should bring radical changes to the industry. Demoralized conditions of labor following the Civil War necessitated changes in the methods of growing cotton. Many of the large antebellum plantations were subdivided into small farms, to be rented or to be cultivated on the "share system." These conditions prevail generally at the present time.

The increase in the supply of labor in the Southern States has not kept pace in recent years with the requirements for the general industrial development in that section, and cotton growing in some localities has been embarrassed thereby. However, the better prices which have been commanded by the staple of late years, and the consequent ability of the grower to pay better wages, together with the increase of conveniences for living in the country, evidenced by the appearance of the telephone and the free delivery of mail, are tending to check the movement of the population from rural districts.

The use of commercial fertilizers has been a very important factor in the development of cotton growing. Prior to the Civil War the crop was grown continuously on the same land without any attempt to prevent the depletion of the soil. The expensive labor which resulted from the war

made it advisable "to make two ears of corn and two blades of grass grow where only one grew before." This condition of enforced economy made it necessary to grow and harvest more cotton on less land and with the least possible amount of labor. By breaking the soil to the proper depth, it has been found that the taproot of the plant is enabled to sink deeper into the soil and the cotton fibre is thus materially increased in length and in uniformity. This method of deep preparation also protects the soil against washing. It has been found to be valuable as a means of drainage in seasons of excessive rainfall and also a proper means of preventing damage from prolonged droughts. It is interesting to observe that the intensive system of farming, which involves a thorough preparation of the soil and the use of commercial fertilizers, rotation with leguminous crops, and rapid and intelligent cultivation, had its beginning in South Carolina about 1857. However, the use of this system for many years was quite desultory, and did not, until very recently, receive general consideration.

There can be no question that from thirty to fifty per cent profit will result from the judicious use of fertilizers; which not only increases the size of the plant but makes it easier and less expensive to cultivate, adding to the yield without increasing the labor or acreage, and actually enlarges the climatic area within which cotton may be profitably grown. As fertilizing hastens the maturity of the crop, it is a valuable guard against the ravages of insects, especially the boll weevil.

Transportation facilities have also contributed to the development of cotton growing. While many navigable streams running through the cotton belt helped the grower to market his crop by boat in the earlier stages of the industry, in later years railroads have offered far more satisfactory means of transportation.

Cotton growing in the United States has been especially favored by the character of the soil and of the climate. Perhaps nowhere else are the conditions of heat, moisture and soil so well adapted to it. This country holds the first rank in cotton growing, because of these factors, by a long growing season, ample rainfall, and a suitable season for harvesting.

The development of the cotton industry and trade of the United States is fully set forth in the figures of the table which is shown upon page 5.

The statistics of the table show that there was a very rapid growth in the production between 1790 and 1800, due very largely to the invention of the saw-gin; that there was a marked decrease between 1860 and 1870, due to the Civil War; and that since 1870 the production has gone on increasing until a crop of 13,500,000 bales of 500 pounds each for the United States and 20,000,000 bales for the world, are but reasonable and necessary results. Of the world's suppply of cotton for mill consumption the United States contributes about sixty-five per cent; British India, nineteen per cent; Egypt, seven per cent; Russia, three per cent; with the other countries of the world producing the remaining six per cent.

Production, Consumption, Exports and Imports of Cotton for the United States by Five-Year Periods Since 1790.

Year	PRODUCTION				Consumption (500-pound bales)	Exports of domestic cotton (500-pound bales)	Net imports (500-pound bales)
	Running bales counting round as half bales (number)	Equivalent 500-pound bales, gross weight (number)	Average net weight of bale lbs.	Value of lint per pound, upland cotton (cents)			
1910	11,083,337	10,315,382	475	14.3	....	....	....
1905	10,725,602	10,804,556	482	10.9	4,877,465	6,975,494	133,464
1900	10,245,602	10,266,527	480	9.3	3,603,516	6,860,917	116,610
1895	7,161,094	7,146,772	477	8.2	2,499,731	4,761,505	112,001
1890	8,652,597	8,562,089	473	8.6	2,604,491	5,850,219	45,580
1885	6,575,691	6,369,341	463	9.4	2,094,682	4,200,647	8,270
1880	6,605,750	6,356,998	460	11.3	1,865,922	4,453,495	5,447
1875	4,632,313	4,302,818	444	13.0	1,255,712	3,037,650	4,498
1870	4,352,317	4,024,527	442	17.0	1,026,583	2,922,757	1,802
1865	2,269,316	2,093,658	441	43.2	614,540	1,301,146	10,322
1860	3,849,469	3,841,416	477	13.0	841,975	615,032	......
1855	3,665,557	3,220,782	420	10.3	731,484	2,702,863	2,295
1850	2,454,442	2,136,083	416	12.1	422,626	1,854,474	330
1845	2,100,537	1,806,110	411	7.9	363,365	1,095,116	386
1840	1,634,954	1,347,640	394	9.5	245,045	1,060,408	1,210
1835	1,360,725	1,061,821	373	16.5	184,731	847,263	427
1830	1,026,393	732,218	341	9.7	129,938	553,960	22
1825	817,308	533,473	312	12.2	124,481	409,071	79
1820	575,540	334,728	278	14.3	100,000	249,787	427
1815	369,004	209,205	271	29.0	45,346	163,894	35
1810	286,195	177,824	297	15.5	35,565	124,116	431
1805	304,348	146,444	230	22.0	76,080	71,315	961
1800	153,509	73,222	228	44.0	18,829	41,822	8,696
1795	35,556	16,736	225	36.5	13,260	12,213	8,737
1790	6,667	3,138	225	26.0	11,000	379	697

Harvesting and handling cotton.—Cotton picking is general throughout the United States by September 1 and continues until about January 1 following. In southern Texas, cotton is picked as early as the 15th of June, and in the Mississippi and Red rivers, sometimes as late as the 15th of March. The fields are picked over three or four times during a season when labor is plentiful, but when labor is scarce they sometimes remain untouched until all the bolls are open, when the crop is gathered at one picking. The expense for picking the cotton is the largest item in the cost of production. For upland cotton it amounts to about twenty per cent of the entire cost and for sea-island cotton it is slightly more. The entire crop is still picked by hand, just as it was in the beginning of the cotton growing industry. While one man with proper machinery can cultivate thirty acres, it requires four pickers to gather the crop as rapidly as is necessary to prevent loss. A fair average day's work for a cotton picker during a season is about one hundred pounds of seed cotton. At such a rate it would require about one and one-half million persons, working four months, to gather the average season's crop and would involve the ex-

penditure of more than ten per cent of the value of the crop. (See Plate 1.) The industry is very much hampered by the lack of mechanical appliances for harvesting the crop. Numerous attempts have been made to invent a machine for picking cotton, but none of these has been successful, since all of them have revealed such defects in practical working as to prevent their adoption. The chief difficulty in perfecting a mechanical cotton picker is the irregular ripening of the cotton. Scientists may be able to overcome this obstacle. Cultural methods and research may lead to the development of a cotton plant on which a large percentage of the bolls will mature uniformly. Florists have brought about such uniformity in the blossoming of flowers, and a careful study of the cotton plant will certainly result in interesting and valuable developments for it.

The early method of handling cotton at the gin was exceedingly laborious, wasteful, and unhealthy. Much has been done in recent years in the way of combing, ginning and baling plants so that speed might be increased and labor economized. A modern ginnery containing three gins of seventy saws each and a double square-bale press, is presented in the accompanying illustration. (See Plate 2.)

From the hand seeder, advance was made first to the animal power gin, which, with a forty-saw capacity, yielded about two thousand pounds of lint cotton per day, and then to the complete battery ginnery, carrying in some instances as many as fifteen gins, each with seventy saws, operated by steam power and having a capacity of 150 bales, or 75,000 pounds, in twelve hours. The condenser and automatic feed press have superseded the old wooden screw. The laborious handling of the seed is avoided, it being blown either into a seed room or into the waiting wagon of the owner. In this way the life and value of the seed are better preserved in conformity with the requirements of the oil mill. (See Cotton Seed and its Uses, *Ibid.*)

Much complaint has been made by the consumers of American cotton as to the careless methods of baling and wrapping. Unnecessary waste, deterioration in quality, and greater danger from fire are among the disadvantages resulting from the present practices. The demand for a neater bale is both warranted and urgent. In many instances, the American cotton is not uniformly distributed, and the bale is sometimes several inches thicker at one end than the other. When these loosely pressed bales reach the compress or the consumer they are frequently in a dilapidated condition, brought about to a large extent by the practice of each of the several bidders ripping open the covering and extracting samples of the cotton. In this condition the bale is as easily ignited as tinder.

One of the most interesting features in connection with the cotton growing industry is the ultilization of the seed which at one time was practically a waste product. Although several cottonseed oil mills had been built in the United States prior to 1840, the industry did not reach com-

mercial importance before 1870. While there were only 7 cottonseed oil mills in the United States in 1860, there were 26 in 1870, 119 in 1890, 369 in 1900, while at the present time there are more than 800. The amount of capital invested in the industry at the present time is about $100,000,000, and the value of crude products manufactured annually is more than $100,000,000.

The value of the American cotton crop, including the seed, amounts annually to approximately $800,000,000.

Collection of cotton statistics.—Much attention is given to the collection of cotton statistics. Exchanges, brokers, and trade journals expend hundreds of thousands of dollars annually in the collection of information relative to the condition of the crop during the growing season, and regarding the commercial movement of cotton during the harvesting season. Many trained statisticians devote their time exclusively to these statistical endeavors. The expenditures made by the National Government and by the several cotton-growing states and other local subdivisions in the interest of cotton, not including the cost of educational work in the schools, colleges, and institutes, amount to approximately $1,000,000 annually. Of this, probably one-third is devoted to cotton at the experiment stations, one-third to statistical inquiries, and the remaining one-third to special phases of the plant and its enemies. A number of bureaus in several departments of the National Government are now charged with work relative to some phase of the cotton industry, and the general scope and importance of these endeavors are indicated by naming the character of the investigations.

Bureaus of National Government charged with cotton investigations.

BUREAU.	Character of investigation.
Department of Commerce and Labor:	
Census	Statistics, each season, of cotton ginned to specified dates, and of stocks, and of consumption of cotton; statistics of acreage and production decennially from a canvass of the growers; and special reports on cotton manufactures and cotton-seed products at five-year periods.
Statistics	Statistics of exports and imports of cotton and its manufactures and of cotton-seed products; also, statistics relative to the internal and coastwise movement of cotton.
Manufactures	Information relative to foreign markets for cotton and cotton-seed products.
Corporations	Special investigations as authorized by Congress
Labor	Special investigations relative to wages paid, cost of living, and other conditions affecting labor in the cotton industry.

BUREAU.	Character of investigation (*continued*).
Department of Agriculture: Statistics	Estimated statistics of acreage and production and information relative to condition of crop during growing period.
Plant Industry	Information relative to farmers' coöperative demonstration and farm-management work; cotton breeding; cotton acclimatization; cotton standardization, and cotton diseases.
Entomology	Information relative to Mexican boll weevil and other insect pests.
Soils	Information relative to condition of soils; methods of treatment, and fertilizers.
Office of Experiment Stations	Information relative to experiments of agricultural colleges and stations; collection and dissemination of general information regarding the colleges and stations, and of investigations in this and other countries.
Weather	Information relative to rainfall; temperature, and meteorological conditions.
Biological Survey	Economic relation of birds with regard to insects and other pests.
Office of Public Roads	Questions and conditions relative to practical road building.
Interstate Commerce Commission	Hearing of complaints relative to discrimination in freight rates.

Part II—In Other Countries

BY E. M. NORRIS

Cotton is produced by all the species of the genus gossypium, which belongs to the natural order of the Malvacea; it is allied to mallow, hollyhock, and hibiscus, the resemblance being very apparent both as regards the foliage and the flowers. The species are herbaceous, shrub, and trees, either perennial or annual. It is indigenous to the tropical and sub-tropical parts of Asia, Africa, America, and all of Australia, but its cultivation has extended far into the temperate zones. All the species have leaves with three to five lobes, rather large flowers, sometimes purple, or partially so, but usually yellow. The flowers soon fall. They grow singly from the axils of the leaves, and are surrounded at the base by three large heart-shaped, toothed involucral leaves or bracts, partially growing together as one. The fruit is a three to five-celled capsule, springing open when ripe, and contains numerous seeds enveloped in cotton which issues from the capsule after it has burst open. The species are numerous. Linnæus enumerated five, Lamarck in the Encyclopédia Methodique enumerates eight specimens. Cavanilles and Willdenow recognize ten. According to the latter, the following species are distinct from each other: (1) Gossypium herbaceum. (2) G. Indicum. (3) G. Micranthum. (4) G. Arboreum. (5) G. Vitifolium. (6) G. hirsutum. (7) G. religiosum. (8) G. latifolium. (9) G. Barbadense. (10) G. Peruvianum. Cultivators usually divide all into four primary species, each of which has several varieties;

some cotton planters having recognized not less than a hundred. These four species are: (1) Gossypium barbadense, the most valuable of which, the beautiful long-stapled "Sea-Island" is a variety and is grown upon the islands and a portion of the mainland of Georgia, South Carolina, and Florida, the saline ingredients of the atmosphere being indispensable to its growth. Egyptian cotton belongs also to Gossypium Barbadense. This plant bears a yellow flower and a small, black seed. The character of the plant changes when it is grown far inland, the seed becoming large and hairy. (2) Gossypium herbaceum pertains to India, China, Egypt, etc., the principal varieties being known as Surat, Madras, and short-stapled Egyptian, and it is grown in America, being known as American Uplands. It is a small shrub, having a yellow flower; the seeds are covered with a greenish down and the staple is smooth and silky, although short. It is hardy, and can be produced farther north than any other species of the cotton plant. (3) G. Peruvianum is a native of South America, of which the green-seed cotton of the United States is a variety. The stem is ten to fifteen feet in height, the flowers are yellow, and the pods contain eight or ten black seeds, firmly attached in a cone-like mass. The staple is long and strong, and the cotton stands next in value to Sea-Island, and long-stapled Egyptian. (4) G. Arboreum is a large tree-like plant found in India, China, and varieties of it have long been successfully cultivated in the United States. It has a red flower and produces fine yellowish-white wool, somewhat like Sea-Island, when climate and soil are favorable. The plant is perennial and will produce fibre (in good seasons, two crops) for five to seven years in succession.

According to some authorities, cotton derives its name from the Latin name for quince, cotoneum malum. Pliny speaks of "wool-bearing trees," which he says "bear fruit like a gourd, and of the size of a quince, which, bursting when it is ripe, displays a ball of downy wool, from which are made costly garments of a fabric resembling linen." One species of quince has leaves covered on the upper side with downy wool, similar to the leaves of cotton, and this, according to the etymologist Skinner, and to Johnson, led to the application of the word cotoneum to cotton. If this is correct, the name did not come to the English language direct from the Latin, but is derived from the Arabic. The Arabic word in European characters is kotôn, and is pronounced goottn. The Italians and Spaniards, who first received cotton from the Moors, took their name for the substance—the Italians calling it cotonc, and the Spaniards, algodon, that is, godon with the article "al" prefixed.

The cotton plant is a very delicate organism, and for its fullest and best development is peculiarly dependent upon a fitting soil and climate. The method of cultivation is practically the same in all countries where the fibre is grown, but it more nearly approaches perfection in the United States. Sowing is done from March to May (according to greater or lesser degrees

of spring frost) and picking begins in August and continues until the beginning of November. The cottons grown in the United States, which is the largest producer of the raw material, are varied in kind and excellent in quality, owing to the adaptability of the climate, the scientific methods of cultivation, and the careful manner in which it is prepared for the market. Sea-Island, grown on all the islands off the coast or directly upon the coast of South Carolina and Georgia, is the best cotton in the world, and accordingly brings the highest prices. The staple is one and three-quarters to two and one-half inches long. The fibre is extremely silky, fine but strong, and can be spun to the highest counts of yarn. English authorities claim that in one instance it was spun into counts which afforded 2,150 hanks to the pound. A pound of such yarn would measure one thousand yards. Grown far from the coast in the above-mentioned States, it is from one and one-half to two inches in the length of its staple and can be spun up to 200's for ply yarn. Florida Sea-Island is grown on the mainland of Florida from Sea-Island seed. It is strong and rather coarser than Sea-Island, the staple being shorter, nor is it so carefully cultivated as the Sea-Island.

The cotton crop of India is inferior in quantity only to that of the United States. For many years the cultivation and manufacture of cotton has been fostered by the British government in India. In the plains of Bengal, the cotton raised, though short in staple, was the finest grown in the world and formed the material out of which the exquisitely delicate Dacca muslins were fabricated. It was known as Dacca cotton, and the plant is a distinct variety of Gossypium Herbaceum. What little is raised is used at home in the looms of a few native weavers. The cotton from the Deccan, or Central India, is the best Indian cotton exported; the staple is about seven-eighths to one inch. Southern India also produces some of the best cotton grown in that country, which, however, owing to the conditions of its cultivation and preparation for market is short of staple and dirty. India exports much of her cotton to England as raw material, and consumes an immense amount in her own mills.

Much attention has been given by the British government in India to the fostering of the cotton growing industry, and the ginning and preparing of the staple for the market, many experiments having been made in regard to the choice of seed for the various localities, cause of deterioration, best methods of cultivation, etc. The variety called Indian cotton is more naturally adapted to the dry climate of India since it has a long taproot which enables it to draw sustenance and moisture from greater depths of the soil than the American species with its lateral roots spreading near the surface. Many experiments have also been made in ginning, the machine most in use being a roller gin of the improved Macarthy type. Nothwithstanding these efforts, the cotton is inferior as compared with Sea-Island

and the best grades of long-stapled American, and comes into the market in a dirty condition.

Through the efforts of the British Cotton Growing Association, the area under cultivation in India was increased from 18,025,000 acres in the crop year 1903 to 20,001,000 acres in the season of 1905; to 22,488,000 in 1906; 21,630,000 in 1907; 19,999,000 in 1908; 20,227,000 in 1909. And the efforts of the Association are also bent on improving the quality of the fibre and bettering its preparation for market.

China produces about one and one-quarter to one and one-half million bales of a rather short-stapled cotton, which is somewhat harsh to the touch, and very white. It has the quality of mixing well with wool. The crops are entirely consumed in the domestic manufactures. Cotton of a similar type is also grown in Japan and Corea, and that also is used in the home manufacture, Japan importing more than she grows.

Egypt is the fourth in point of amount of the cotton-producing countries of the world. From time immemorial, a fine quality of cotton has been grown in the upper region of the Nile, particularly in Abyssinia. (See Egyptian Cotton, by Blaisdell, *Ibid.*)

In 1906-07, the cotton crop in Egypt was the largest ever grown in that country, amounting to 6,949,783 cantars (the cantar equals 99 pounds), practically every bale being consumed early in the year. The total shipments to all countries from Egypt were 921,726 bales, averaging 725 pounds net weight. Of these, America, owing to a shortage caused by the Gulf storm in 1906, took 119,850.

We give the following particulars in regard to cotton growing in Africa other than Egypt. The shortage of cotton in 1903-04, and the subsequent attempt to corner a market brought about the formation of the British Cotton Growing Association, which operates under a royal charter, with a paid-up capital of $1,250,000, which has as its object the cultivation of cotton in the British colonial possessions and dependencies lying within the latitudes of what may be termed the "cotton belt" of the world. Professor Wyndham R. Dunstan, F. R. S., director of the Imperial Institute, South Kensington, asserts that "cotton may be successfully grown in those countries which fall in a region lying, roughly, forty degrees North and South of the Equator, providing that the soil is appropriate, and that the rainfall or irrigation is sufficient. Within this region, the following British colonies, protectorates, and dependencies are included: British Honduras, the West Indies, British Guiana, Gambia, Sierra Leone, the Gold Coast, Lagos, and Nigeria, East Africa and Uganda, South Africa, Mauritius, the Seychelles, India, the Straits Settlements, and Federated Malay States, Australia, New Guinea, Liji, Egypt, Cyprus and Malta. In most of these countries, the rainfall is adequate, and in those in which it is deficient, irrigation is possible in nearly every instance."

It was impossible at the outset for the Association to extend its

operations over so wide a field; the West Indies, Africa, and India were therefore chosen as the spots in which to make the initial efforts, and the experiments carried out since then have definitely proved that large quantities of cotton can be grown in the British Empire. The Association supplies seed without charge for experimental purposes, and was instrumental in obtaining through the government grants-in-aid from the local governments in Africa, which were allowed annually until March 31, 1910, as follows:

Southern Nigeria	5,000
Northern Nigeria	1,000
Gold Coast	1,500
British East Africa	1,000

The Association contributed a like amount and an agreement was made that the whole of the £17,000 should be annually spent in experimental and instructional work. Money has been loaned to planters and ginning stations have been established.

In 1907, a serious drought throughout the whole of West Africa, during the growing period of the crop, seriously affected the returns. Progress on the Gold Coast is slow; the quality is satisfactory, but it is feared some years must elapse before an appreciable amount is obtained. In Lagos, the quality of the cotton has been greatly improved. Northern Nigeria produces from 50,000 to 80,000 bales of a good quality. Uganda promises extremely well as a cotton-growing country, the quality proving excellent. Mr. Winston Churchill, as Under Secretary of State to the Colonies, visited East Africa and Uganda in 1908, and reported that in Uganda alone there were over 20,000 square miles (12,800,000 acres) suitable for cotton cultivation and over 1,000,000 farmers. In Nyassaland, cotton growing has made solid progress; cotton of a superior Upland type can be grown in the highlands, but the cultivation of Egyptian in the lowlands has not yet proved a conspicuous success. In Rhodesia, where much newly cleared land was planted, the results were not eminently satisfactory, as cotton does not do well in such ground. A number of white planters have been growing good cotton in Eastern Rhodesia, and gins and presses have been sent out. Very satisfactory cotton has been grown in the Transvaal under the auspices of the Zontpausberg Cotton Syndicate. Some little experimenting has been done in Natal, and in Cape Colony some most beautiful samples of cotton have been grown, but the attempt has not passed beyond the experimental stage,

The Government is proceeding to the task of building railways, through the cotton-growing districts, so that the crops may be expeditiously conveyed to the shipping points. Those who are qualified to forecast the future of the cotton-growing industry of Africa, declare that they

are not unduly optimistic in predicting that the crops will increase in a steady yearly ratio until the production ultimately reaches the amount of 5,000,000 bales per annum.

BALES OF 400 POUNDS.

	1903	1904	1905	1906	1907	1908
Gambia	50	100	300			
Sierra Leone	50	100	200	150	100	
Gold Coast	50	150	200	200	250	200
Lagos	500	2,000	3,200	6,000	9,500	5,500
Southern Nigeria	50	100	150	150	250	200
Northern Nigeria	50	100	500	1,000	1,500	500
Total for West Africa..	750	2,550	4,550	7,500	11,600	6,400
Uganda				500	2,000	5,000
British East Africa....				200	200	300
Nyarsaland				2,200	2,300	1,500
Rhodesia				100	200	300
Total for East Africa..	150	850	2,000	3,000	4,700	7,100

A course similar to that of the English has been taken by the French in regard to their African colonies. We glean many interesting facts from a report prepared by the "Association-Cotonnière Colonial." In Algeria, ginning factories have been established with hydraulic presses for the baling of the cotton in several sections, and three co-operative cotton-growing companies were formed in Orleansville, Philippeville and Bône; each company has established ginneries which are run by electric plants.

In Algiers, experiments led to the conclusion that Mississippi seed did well in the districts of Philippeville, Guelma and Batna, where irrigation is not possible, yielding a remunerative crop in spite of the lack of rain. In the plains of Sig. Perrégaux, Orleansville, up to Blida where irrigation is possible, the great majority of the planters have adapted Mit-afifi. In these plains, it gives a yield varying from 14 to 22 hundredweight of cotton per hectare, which is a larger yield than that of the same variety in Egypt, and a successful trial has been made with bi-annual cultivation at Chelif, where cotton is in its very element. In the Soudan, the work was mostly limited to the installation of ginneries. Experiments of irrigation are in course at Richard-Toll, where ten to twenty hectares are to be cultivated, experimentally. Dahomey crops are good and increasing. The seed is smooth and the fibre excellent. In other colonies good progress has been made, especially in Guadeloupe, where ginning and pressing machinery has been imported. In New Caledonia the extension of cotton cultivation is most marked, Caravonica cotton being that best suited for the island, the same variety showing good results in northeastern parts of Madagas-

car. Tahiti and the Somalis Coast also show an extension of cotton cultivation. The following table gives a definite idea as to what is being done in this direction:

Cotton Produced in the French Colonies in 1907-08:

	1907	1908
Higher Senegal and Niger...........	40,190	18,250
Dahomey	91,445	59,035
Algiers	31,725	60,400
Guadeloupe	1,042	16,150
New Caledonia		5,000
Reunion		950
Madagascar and Comores		10,240
Somalis Coast		500
Tahiti		1,000
	164,402	171,525
	750 bales	780 bales

In the German colonies much has been done on the same lines and the success is inspiring. For Togo the output for 1907-08 was 1,691 bales of ginned cotton, as compared with 1,205 bales in the year 1906-07, an increase of over forty per cent. Ginning factories have been established at all the large centres. In Cameroon, experimentation is still in its preparatory stages. The building of railroads and the waterway Niger-Benne will probably open out wide districts. Native cotton grown at Alkassim, in North Carolina, has been valued in Germany as fully equal to middling Texas. In New Guinea the cultivation is still in the earlier stages of experiment. In German East Africa the cultivation has made satisfactory progress, and cotton growing by the natives is now on a firm footing in the Rufidji district. The cotton crop in German East Africa for 1907-08 was about 1,600 bales, an increase of about 850 bales as compared with the year before. In Russia a large amount of cotton is grown, the cotton area lying within the Asiatic Territory of the Russian Empire in Turkestan and Transcaucasia. In the former, cotton has been cultivated from the most ancient times, being chiefly grown on lands not needed for the prime necessities of life, such as wheat, rice, barley and other staples. Cotton cultivation here attained its greatest development soon after 1860, when the Russian cotton trade was suffering from the effects of the war in the United States. Since then Russia has devoted a great deal of attention to the development of the plant, and the culture was encouraged by the government. Upland American cotton was introduced, proved to grow successfully, and energetic measures were taken for its cultivation, seeds

being distributed free of cost to those who desired them, and manuals in regard to the cultivation of the American Upland were published in the Russian and local languages; and in 1890, 245,000 acres produced more than 45,600,000 pounds of clean fibre. The native cotton is cleaned by the primitive wooden roller machines worked by hand power. But nearly all the Upland cotton is sent to ginning mills, where modern, and in most cases, American gins are worked by water or by steam. In 1893 there were about 100 of these mills in Turkestan with more than 400 gins and 120 presses.

Cotton for Russia in Europe is shipped from other countries of Central Asia; namely, Bokhara, Khiva and the Transcaspian territory. Bokhara produces about 54,000,000 pounds of cotton of the Asiatic variety mainly; Khiva, about 21,000,000 native variety, but vastly superior to other Asiatic growths. The Transcaspian territory grows but 360,000 pounds, mostly Upland. The aggregate product of all the Central Asiatic countries is 144,000,000 pounds, three-fourths of which is sent to European Russia. In Transcaucasia there are about 100,000 acres devoted to the cultivation of cotton, mainly native, for Upland has not displaced the variety planted by the natives from very early times. The yield is about 230 pounds per acre. In the Province of Samarkind American cotton is rapidly taking the lead, as it is in the Province of Khojind also. In addition to her large crops, Russia also imports a great quantity of cotton from the United States, Great Britain, Germany and Egypt.

In the British West Indies experiments have been made under the auspices of the British Cotton-Growing Association. Sir Daniel Morris, the imperial director of agriculture for the West Indies, had already accomplished much of the pioneer work, and the assistance of the association was confined to setting up several ginneries and extending financial aid to needy planters. The cotton grown was the finest Sea Island, and in 1907, there were 5,057 bales of it shipped to England.

Brazil sends into the market a large amount of poorly-cultivated and badly-ginned cotton. It is somewhat wiry in the fibre, the staple being a trifle longer than that grown in the Cotton Belt.

From Peru, we have three varieties, Sea Island, Rough and Smooth. The Rough Peruvian is of the most importance, because of its similarity to wool, which renders it of great value for mingling with wool in the making of merino woolens. It has a woolly, crinkled staple about one and one-fourth to one and one-half inches long; it is clean and well prepared, and, when carded, its resemblance to wool is so close that it could be sold as that commodity even to a dealer. Like wool, it takes the dye readily, and holds it fast. When mixed with wool, it reduces the tendency to shrinkage in the wool with which it is combined; it renders the goods more durable and less expensive to produce, and gives them a better lustre and finish. This "vegetable wool," as it is called, is largely imported

into the United States, chiefly for the use of manufacturers of woolen goods. Some of this cotton, grown on copper soil, is quite "Red." The "Smooth Peruvian" is shorter and resembles the Gulf Cotton of the United States, while the Sea Island resembles Florida Sea Island.

The production of cotton in Mexico in 1909 was estimated at 125,000 bales of 500 pounds each. Turkey produced 70,000 bales of cotton in 1909.

Considerable quantities of cotton are grown in other countries, among which are Greece, with about 15,500 bales; Italy, 10,000 bales; Indo-China, 15,000 bales; Africa, other than Egypt, 25,000 bales; Haiti, 10,000 bales; Dutch East Indies, 10,000 bales; Japan, 5,000 bales; Korea, 5,000 bales; Argentina, about 5,000 bales, and the Philippine Islands, 4,000 bales. While cotton growing in Australia has not passed the experimental stage, the present indications in Queensland are promising. The institution by the commonwealth of a bonus to the growers is serving as an incentive, but the requirements for local consumption will readily absorb the production.

EGYPTIAN COTTON

BY C. M. BLAISDELL

The introduction of cotton into Egypt is due to a certain Mako Bey, who, about the year 1820, made the first attempts in his property near Alexandria. It is from him that the "Mako Cotton" or "Mako Baumwolle," principally employed in Germany, comes. The French call the same thing "Tumel Cotton," after a certain Tumel, gardener of Mako Bey, who occupied himself principally with these plantations.

This culture, protected by the Vice King, Mehemed Aly, acquired some importance in a few years. But the great development of the industry occurred after the "Civil War" in America, on account of the fabulous prices that were paid at that time.

It is not positively known where the first seeds came from, or if the primitive color was brown, or if this color was acquired from atmospheric influences or the action of the soil. Since it has been used for manufacturing it has been distinguished by four principal qualities, long fibre, strength, silkiness of texture and dark color. It is an established fact that the same seed planted in the different districts does not give the same results, either in quality or quantity. Whether it be the climatic influences or peculiarities of the soil that contribute to produce a cotton more or less long, silky, and even of slight difference in color, is not known.

These influences, together with the carelessness of the cultivators in the choice of seed, may have contributed to the degeneration of the original stock, while the crossing of plants has made new varieties and regenerated or changed the product of the country. Within the last few years the government has interested itself seriously in the cultivation of cotton by encouraging the cultivators in the choice of good seed, and in discovering more productive varieties.

The principal varieties of Egyptian Cotton are the following:

Brown Cotton.

1. Achmouni, discovered somewhere in the seventies, in the village of "Achmoun," province of Garbieh. This cotton was for a long time the principal textile product of the country, yielding at least two and one-half to three cantars the Yeddan (one Yeddan, 4200 square metres). Now it is entirely abandoned in lower Egypt, while the cultivation is continued in

upper Egypt. The product is, on account of the sandy soil, a little woolly and of a light shade, but of a tolerably strong fibre and healthy.

2. Bamia, so-called on account of its resemblance to "Bamiet," a vegetable of the country. The color is almost identical with the Achmouni, but the fibre is longer and stronger. The seed was found about 1890 in the Province of Dakahlich, and gave from the beginning good results. The culture has been limited, because a good deal of the soil does not seem suited to it and because it is very susceptible to inclement weather, especially fogs. It is planted in parts of Dakahlich (Mansuza), Garbieh (Samaund Mahalla), and the product constitutes scarcely three to four per cent of the entire harvest. It is the cotton represented by our types 13 and 14. The return in good years is four-fifths cantars the Yeddan.

3. Mit Afifi. This cotton originated in the village of Mit Afifi, Province of Menonfieh. The color is darker than the Achmouni and Bamia. The fibre is fine and strong. As it grows much faster than the other two varieties, it is less exposed to the fogs of autumn, and the plant is not so delicate. This explains its superior yield, which is three and one-half to six cantars the Yeddan. On account of these advantages, the cultivation of the Mit Afifi spreads rapidly all through lower Egypt, and constitutes seven-eighths of the entire crop. The best qualities are furnished by the Province of Menonfieh and the Southern part of Garbieh, especially the districts of Cafre, Layat, Tantah and Birket-el-Sab; the silk is long, fine and strong. It is the cotton of our types 15, 16 and 17. In Behera and the Northern part of Garbieh, the product has generally a shorter fibre, but fine; so that it passes for Nos. 16, 17 and 18 when the customer does not desire an especially long fibre. Clarkieh, Galionbieh and Dakahlieh furnish a less fine cotton, but strong and healthy, which goes in large quantities for the types 18 and 22.

4. Gallini. Cotton very fine, long and strong, resembling Sea Island. It was for a long time the principal product of the North of Garbieh. But having degenerated and given results less and less satisfactory, the culture was abandoned.

5. Coton blanc. (White cotton.) The seed was introduced from America during the War of the Rebellion. Several districts, principally Lifta, Lamanoud and Birket-el-Sab, were well adapted to this culture which for twenty years was very extensive, yielding four to five cantars the Yeddan. This cotton constituted about twenty per cent of the entire crop, but since that time it has slightly degenerated and given place to other more lucrative varieties. To-day it constitutes only three or four per cent of the crop.

6. Sea Island. Seed imported from America, cultivated only in a small strip and soon abandoned completely on account of its very meagre returns.

7. Hamouli. White variety, cultivated in small proportions for some years. Actually it has already degenerated and is mixed with Mit Afifi.

8. Lafiri. White cotton, discovered within a few years by a certain Mr. Lafiri. The fibre is long, strong and fine. The returns are said to be superior to that of the Mit Afifi. Nevertheless, the cultivation has not extended beyond simple trials.

9. Abbassy. White cotton, fine and long, discovered recently by a certain Parachimonas who named it Abssy, in honor of the Vice King Abbas Hilmi. The trials made in 1907 gave a return of eight to ten cantars the Yeddan. Trials are to be made on a much larger scale, but it is impossible as yet to give an estimate of the result.

Cultivation on a grand scale never yields the same result as a trial on a small extent of ground, which naturally receives the most minute care and attention. But if the highest hopes are realized only in part, this cotton will doubtless augment materially the Egyptian harvest. The production of cotton in upper Egypt in comparison to the total crop is insignificant. It amounts to 200,000 to 250,000 cantars per year, two to three per cent of the entire crop. Nevertheless, this culture is susceptible of a great increase when a rational civilization shall secure regular irrigation. The best cotton of these regions is that of Beni-Sonef, tolerably long and fine, while the districts of Zayoun Bibeh Magaga and Minieh furnish a cotton of the same appearance, but generally shorter and more woolly.

The bulk of the crop then comes from lower Egypt, which is divided politically into six principal provinces, of which Menonfieh and Garbieh are in the Delta; Behera at the left, and Galionbieh, Clarkieh and Dahahlieh on the right of the Delta.

We have already mentioned above, the districts which furnish the best cotton. It is necessary, however, to add that a system has been adopted within a few years, of planting seeds from other provinces, which has given good results, and which at the same time diminishes the great difference in quality which existed formerly between the cottons of different provinces.

Generally speaking, the Bamia has the longest fibre, from one and one-half to one and three-fourths inches; the Mit Afifi of Menonfieh, Nos. 15 and 16, approach it equally. The shortest fibre is found in the Province of Zayoum and Behera, which is from one inch to one and one-fourth inches.

COTTON GINNING

The origin of the primitive cotton-gin is lost in the mists of antiquity. From time immemorial, the natives of India pursued the art of manufacturing cotton into cloth and into muslins, and it is obvious that very early in their manipulation of cotton must have arisen the necessity for a mechanical contrivance for separating the lint from the seed. The "churka" or Indian gin must have been almost coincident with the rude wheel for spinning and the simple looms in which they wove the first webs of cotton cloth, we know not how many thousands of years ago.

The churka (See Plate 2) is a small hand-mill or gin, commonly operated by women, and "consists of two rollers of teakwood, fluted longitudinally with five or six grooves and revolving nearly in contact. The upper roller is turned by a handle, and the lower is carried along with it by a perpetual screw at the axis. The cotton is put in at one side and drawn through by the revolving rollers: but the seeds being too large to pass through the opening, are torn off and fall down on the opposite side from the cotton." The churka, in various modifications, still exists all over India, the best-known type of the machine being the Guzerat churka, which consists of two rollers, an upper iron one, of about half an inch in diameter and a lower wooden one of about two inches in diameter. These rollers revolve with unequal rapidity, the iron one much faster than the large wooden one. The common churka is obviously a very crude and imperfect machine: the feeding being done by hand, it was impossible to supply the whole length of the roller and so work it to its full capacity. To atone for the imperfection of the churka, the cotton was subjected to a second process called "bowing." This was performed with a large bow (See Plate 2) made elastic by a combination of strings which, being put into contact with a heap of cotton, the workman strikes the string with a heavy wooden mallet, which operation, while freeing the cotton from dust and husks, raises it to a downy fleece. In the course of ages cotton found its way to all the countries of the East and into Europe, and the churka and bow with it. Still later, the two last named were introduced into America, supposedly from the Bahamas, and the bow gave rise to the commercial phrase, "bowed Georgia cotton." (See Plate 2.) In the Dharwar district of the Southern Mahratta country of India another method of ginning is in use, which is adapted only to the long-stapled, small-seeded cotton grown there. The cleaning of cotton by the foot roller is accomplished thus: "The cotton is spread

over a smooth, flat stone of from one to two feet square, sometimes round, sometimes square shaped: an iron rod eighteen inches long is placed on the stone and a forward rolling motion is imparted to it by the foot of the worker; sometimes the rod is shorter and slightly conical and the motion is then circular, round and round the stone: in both cases the effect is that the seed is squeezed out and pushed away in front of the iron roller, leaving the clean cotton fibre behind it on the stone. From four to six pounds of clean cotton is the output of a day's work."

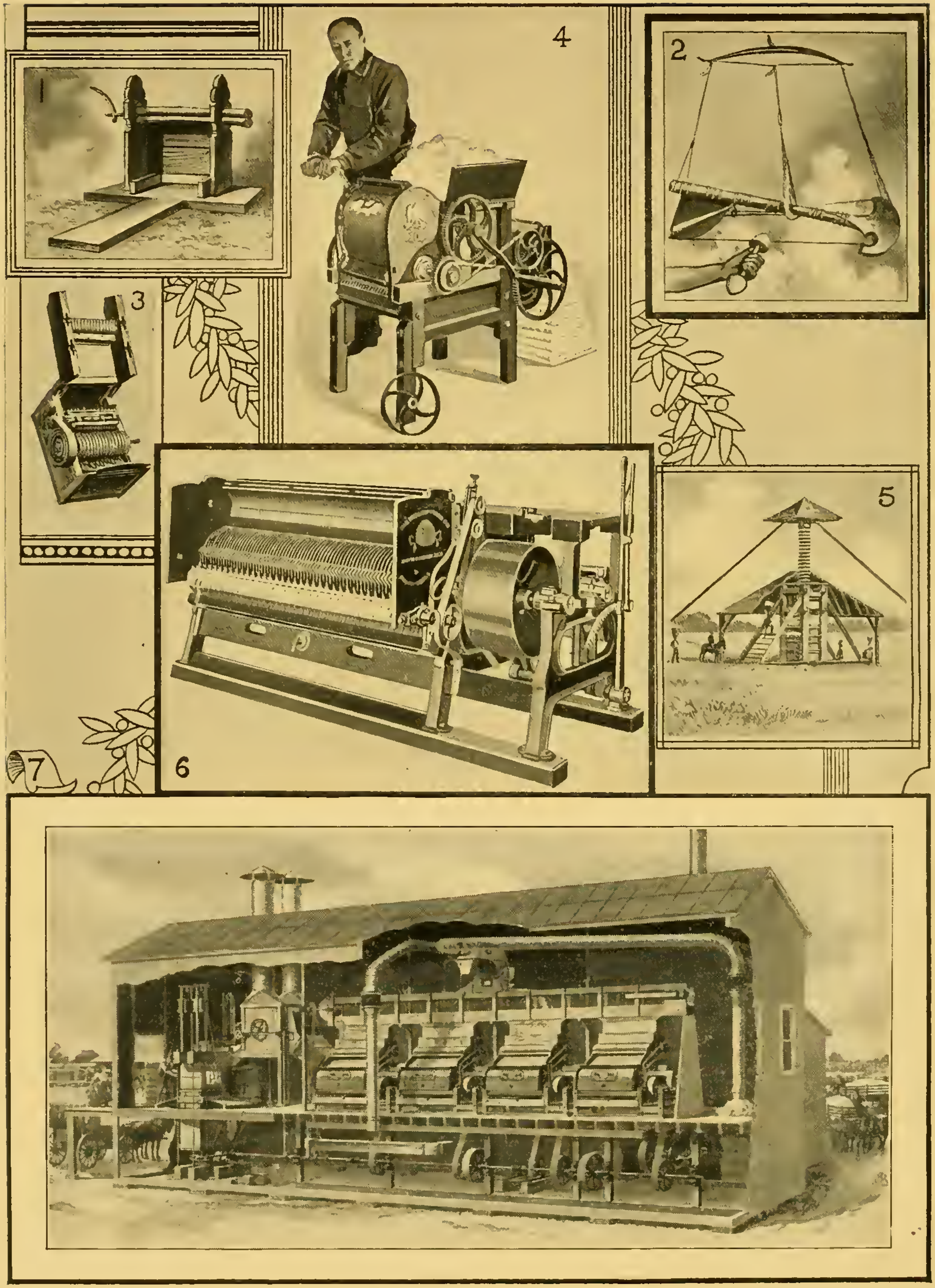
Efforts were made at a very early date in the cultivation of cotton in the South to improve upon the churka, and several roller ginning machines were invented; notably, in 1742, a French planter named Dubreuil invented one of the first machines for separating the seed from the fibre; in 1772, a somewhat similar one was constructed by a Mr. Cribs or Krebs, and a more practical gin was introduced from the Bahama Islands by Dr. Joseph Eve, of Augusta, Ga., about 1790. These roller gins, a modernized and improved application of the principles of the churka, proved admirably serviceable for the ginning of the long-stapled, smooth-seeded Sea Island cotton; but an immense problem confronted the planters of the inland states, that of harvesting and preparing for manufacturing purposes the prolific crops of short-stapled or Upland cotton. Necessity is ever the mother of invention, and when man's need for certain things becomes imperative, ideas spring forth from various sources simultaneously, as though they had been hibernating in men's minds, awaiting the crucial moment. So it was at this epoch of the culture of cotton in America. Hardly had Eli Whitney received a patent for his toothed-roller ginning machine, than Hodgen Holmes invented and received a patent for a gin necessarily similar in some respects to Whitney's, but having toothed plates or circular saws revolving on a cylinder instead of the spiked wooden cylinder of Whitney. The honor of establishing the first practical and productive power gin in the world must be conceded to Hodgen Holmes. This gin was run by water in Fairfield county, South Carolina, by Mr. James Kincaid, in 1795. But we are pressing forward unduly fast.

In 1792, Eli Whitney, a native of Massachusetts and a graduate of Yale College, travelled by boat to Savannah, Ga., intending to penetrate into the interior from that place in the hope of finding a position as a tutor, and thereby to obtain the means to follow the studies which would fit him for the profession of the law. On the boat he met Mrs. Nathaniel Greene, the widow of the American Revolutionary General of that name, and this lady invited him to make her house his home and take up his studies immediately. Whitney had evinced a taste and aptitude for mechanics from boyhood and he at once made himself useful in that direction about his patroness' plantation. At this time, there was no method for cleaning the lint from the seed of the short-stapled, green-seeded Upland cotton but that of hand-picking, a pound of cleaned cotton being the

result of one day's labor of one woman; and the wearied slaves who had wrought all day in the cotton field were set to seed the cotton as their evening's task. Whitney at once set to work, and the result of his experiments was a machine which successfully separated the large, woolly seed from the fibre of the Upland cotton. (See Plate 2.) Whitney's petition for a patent was filed with Thomas Jefferson, Secretary of State, June 20, 1793, and a patent was issued to Eli Whitney, March 14, 1794, signed by George Washington, President; Edmund Randolph, Secretary of State, and William Bradford, Attorney-General. This gin, in the documents filed at the patent office, and in the United States District Court, Savannah, Ga., is described as having a wooden cylinder into which were driven spikes or teeth of iron wire for the purpose of separating the lint from the seed. The patent issued to Hodgen Holmes, May 12, 1796, was signed by George Washington, President; Timothy Pickering, Secretary of State, and Charles Lee, Attorney-General, and was for an improved gin having circular saws fixed at regular intervals upon a cylinder which passed through spaces between ribs. Thus while Whitney's invention of a gin consisting of a wooden cylinder, carrying annular rows of wire spikes, a slotted bar and a clearing brush was fundamental, the practical application of the fundamental idea was completed and carried out in a practical manner by Holmes' invention of a gin with a shaft carrying circular saws, which passed through narrow spaces between ribs. (See Plate 2.)

Immediately upon the receipt of his patent, Whitney entered into partnership with Mr. Miller, of Savannah, in the manufacture of cotton-gins. His idea was to own all the gins and to gin all the cotton produced in the country. Now, after the advent of the gin in 1794, a large crop of cotton was grown for the following season, the planters supposing that it could be prepared for the market by the new gins; but Whitney & Miller could not supply the demand, and, naturally, there was much infringement of the patent and many lawsuits in regard to it. When the heavy crops were ripening on the fields and the gins were not forthcoming, the planters had rough gins made in their own blacksmith shops. Whitney received from South Carolina, as the price of the State rights, $50,000; from North Carolina about $30,000, and from Tennessee about $10,000, his royalties in the Southern States thus amounting to $90,000, a very considerable sum in those days. In Georgia, priority of invention was claimed for a gin invented by Mr. Joseph Watkins, a planter of that State. His machine consisted in part of a wooden cylinder in which were inserted short spikes or teeth of iron wire, and Georgia refused to pay a royalty to Whitney, who, nevertheless, brought twenty-seven suits for infringement of his patent in Savannah, Ga.; of these, a decree for perpetual injunction was issued against Arthur Fort and John Powell; a verdict was granted against Charles Gachel for $1500 and against Isaiah Carter for $2000; judgment in default was allowed in one case; in two cases there

PLATE II—Cotton Ginning



1. The Churka.
2. The Bow.
3. Whitney's Remodeled.
4. Fagle Hand Power.
5. Primitive Cotton Press.
6. Munger Huller.
7. Munger System Outfit.

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was a verdict for the defendant, and the rest of the actions were non-suited or dismissed.

Whether the saw-gin was due wholly to the inventive genius of Whitney or of Holmes, or whether the machine is partially the work of each, is a moot point to-day. The time was ripe for the invention of the saw-gin, it was brought into being and completely revolutionized the cotton-manufacturing trade of America and of Great Britain, and built up the Southern States on a basis of agricultural prosperity. To give some idea of the speedy transformation of the business of producing cotton for manufacturing purposes, note the following figures: In 1792, the amount of cotton marketed was 63,000 bales, of 500 pounds weight each. In 1796, when the saw gin had been in use for barely three years, the amount was 200,000 bales, which, in the year 1909, had risen to the amount of 9,436,400 bales.

Various modifications have from time to time been made in the saw-gin, but none have proved of any commercial value, and the fundamental working principles of the modern saw-gin are the same as when patented by Whitney and Holmes; perhaps it inclines rather more to the Holmes' model, for the operation of Whitney's gin was intermittent; when one breast full was ginned, the operation was suspended in order that the seed might be let out. The Holmes gin worked continuously, the improved form of the breast enabling it to make and carry a revolving roll of cotton, the seed dropping out as the roll of cotton revolved in the breast.

The main features of the modern saw-gin are: 1, a feed box, or hopper, for the seed cotton; 2, a revolving distributer; 3, a cylinder with circular saws; 4, a brush. The parts which were formerly made of wood are now of steel or iron, while the brush, which in Whitney's gin consisted of four cross arms studded with bristles, is now a hollow wooden cylinder, having twenty-five to thirty-five rows of bristles. Various devices have been patented for lessening the friction at the breast, revolving heads at the ends of the breast proving of lasting merit for this purpose. The product of the modern saw-gin is twenty-two pounds seed cotton each hour per saw, or seven pounds lint cotton, turning out 880 pounds from a forty-saw gin; eighty saws is the largest gin made, while the most popular size is the seventy-saw gin, which has a capacity of 1,500 pounds seed cotton per hour; the gins are set in batteries of four so that in the pneumatic elevator system a ginning outfit with four seventy-saw gins would elevate, clean, gin, and bale more than five to six thousand pounds of seed cotton per hour. The speed of the steam-power gin is more than twice that of the mule-power gin, but the gain is questionable. The old proverb, "haste makes waste," holds good in this, as in other matters; the higher the speed the more badly damaged is the staple, and the price obtained is necessarily lower, quality being sacrificed to quantity.

The huller, or double-breasted gin, is a type of saw-gin especially

designed for handling the cotton grown in the lowlands of the Mississippi, Delta and other bottom lands, where the cotton grows large and thick and ripens fast. Some of the dried bolls, which are locally termed "hulls," fail to be separated by the pickers, and this work is accomplished by the "Huller gin," Whitney's spiked roller with Holmes' saw-carrying cylinder. It has a double breast; in the bottom of the outer breast is a spiked roller which combs out the "hulls" as the saws draw the cotton up into the main breast. All parts of this gin are larger in proportion than those of the regular saw-gin, and fewer revolutions are necessary to turn out the same quantity of lint.

At the outset, the saw-gins were set up on the plantations (see Plate 2), a building of wood being erected to house them and to furnish storage for the cotton as it came from the field, a lint room for the cotton as it came from the gin, and another to store the lint until it could be baled; also a place for the running gear, which was usually driven by horse or mule power. As for baling in the older gin houses, there was usually a circular hole cut in the floor of the lint room, and through this aperture a large sack was hung, into which the cotton was packed by hand. Later on, when it became desirable that the bales, to facilitate their transportation, should be of uniform size and shape, and as compact as possible, came the screw press, which was entirely separate from the gin house, though adjacent to it; this was worked by horses or mules until after the Civil War, when small steam engines were used. About eleven plantation hands were employed about the ginnery and press and the ginning and packing of two or three bales was considered a sufficient day's work.

After the close of the war, the emancipation of the slaves gradually brought about a change in the way of doing things; labor was necessarily scarcer and more costly, and many devices were invented for lessening the amount required. A mechanical feeder was attached to the gin, which enabled the ginner to dispense with one helper, and, at the same time, a condenser attachment to catch the lint and deliver it from the gin in a continuous bat did the task of the lint-room hand.

Then followed a compact press, which could be managed by two men, and which was placed conveniently near the condenser. This made help to carry the cotton from the lint room to the press unnecessary, as it did also the mules and men for operating the screw press. Then by degrees the planters adopted the tenant system, and it was found cheaper, simpler and more satisfactory for the planter to buy a steam engine, hire the necessary help and gin for the public at a fixed charge. There were, too, perambulating ginneries, which travelled from plantation to plantation, often doing the work on the cotton field. Then followed well-designed and fitted steam ginneries, equipped with latest labor-saving devices. The greatest difficulty, and that which was last to be overcome,

was the problem of baling. In 1883, Mr. R. S. Munger introduced a pneumatic system of elevating and cleaning cotton, which consisted of a pneumatic elevator which took the cotton out of the wagon or bin, elevated it above the gins, cleaned and delivered the cotton upon a spiked belt, which distributed it into a battery of feeders much better than it could be done by hand. In the feeder it was thoroughly cleaned again before entering the gins (a battery of say four gins), from which it was delivered into a common lint flue attatched to a battery condenser, which separated the air from the lint cotton and formed a continuous bat, fed automatically into a double press box (see Plate 2), thus elevating, cleaning, ginning, baling and pressing the cotton in one operation. While it must be conceded that the saw-gin with its high rate of speed has solved the problem of harvesting the vast crops of Upland cotton grown in the Southern States, it is indubitably true that it injures the staple by cutting the fibre when the saw is worked at a high rate of speed, and unless the gin is carefully managed the cotton is liable to be cut.

There are other important machines for ginning cotton beside the saw-gin. The roller-gin has been brought to a high state of perfection in England for use in Egypt and in India, and many have been brought to the United States for use in ginning the long-stapled Sea Island cotton. A limited quantity of this type of gin is made here, but the ginning machinery business of the United States deals chiefly with the saw-gin. The gin almost invariably used throughout Egypt is that known as the Macarthy patent, self-feeding, single-action, which is particularly suited to long-stapled cotton, and which separates the seeds without crushing them, while the fibre is, as a rule, uninjured. The Macarthy gin, the invention of which is ascribed to an American, in its original and simplest form consisted of a leather roller and two steel blades. One of these steel blades or knives is pressed tightly against the revolving leather roller. The seed cotton in front of it is drawn in by the rough leather surface, and gripped between the blade and the roller until the seed only is kept back at the edge of the knife. To some extent, the mere friction of the leather roller on the fibre will detach the cotton from the seed, but in order to expedite this action, the seeds, as they are held fast at the edge of the fixed blade, are struck off by another blade, to which is imparted a quick reciprocating motion at a very small distance in front of the fixed blade, and thus the seed falls to the ground on one side of the roller, whilst the cotton is delivered on the other. The fixed blade is called the "doctor knife" and the movable blade "the beater." In feeding, as a rule, the seed cotton is placed in front of the roller and doctor knife, on a grid provided with such openings between its bars that the seed can pass through it, only after it has been freed from all the cotton adhering to it. The various gins constructed on the Macarthy principle differ in the construction of the leather roller, in the shape of the beater, and the

modes of imparting motion to it, in the methods adopted for maintaining the pressure of the "doctor knife" on the roller, in the construction of the feeding arrangement and in the speed at which the machines are worked.

The American saw-gin was introduced into India for the manipulation of the acclimatized American cotton grown at Dharwar, and was manufactured at the government saw-gin factory established at that place, but the advocates of the roller-gin in India claim that the superior quality of the fibre prepared by it renders its use desirable even for kinds of cotton in which the saw-gins yield a much greater quantity. "There is no doubt that the roller-gin separates the fibre from the seed with very much less injury to the fabric than is caused by the use of the saw-gin, and in some future time, no doubt, the most improved patterns of it will be widely adopted in the cotton belt of the Southern States."

Mr. Forbes Robertson, in an interesting and minute report of experimental trials made in Madras and Broach in India, and in Manchester, England, in 1879-80, gives some very interesting figures in regard to both roller-gins and saw-gins. He suggests that the great inferiority of the saw-gins in regard to the injury done to the cotton may, perhaps, be due to lack of knowledge as to their manufacture and working on the part of the factory superintendents. In these experiments special notice was taken of an American sixty-saw gin, made by Daniel Pratt, of Prattville, Ala., the machine being an improved and modified Whitney type which was sent to England at the request of Lord Clarendon, then foreign secretary, and the machine received great commendation.

A favorite gin in India is the single-roller, double-action gin of the Macarthy type, which cleans in one hour 25 to 45 pounds of American Upland, Indian, Chinese, and all short-stapled cottons per hour, and 40 to 70 pounds of long-stapled. The double-roller gin, intended for both long and short-stapled cottons, cleans 95 to 125 pounds of short-stapled cotton per hour and 140 to 180 pounds of long-stapled per hour; Dobson & Barlow's single-action knife roller yielded 116 pounds per hour of "Dharwar American" and American Upland, and 140 to 180 pounds of long-stapled cotton. These gins are all 42-inch roller-gins, and a 42-inch roller-gin is equal to an 18-saw gin. As these figures show, the Dobson & Barlow single-action knife roller is not so very far behind the saw-gin in point of quantity, but it is very much better in the point of quality of its work, the cotton cleaned by it being in very fine condition.

The conditions in India can hardly be compared with those of the United States; so much of the cotton growing being done by individuals on small farms or holdings, these usually gin their own cotton in their houses, and for the purpose a cottage churka was some years ago perfected by a Mr. Forbes, who was superintendent of the government cotton-gin works.

We will not go into details here respecting the various gins now

manufactured in the United States as there will be a complete history of each important manufactory of this class of machinery in another part of this work. There were in active operation in the United States in 1909, 26,431 ginneries, with 3,709,835 saws; steam power was employed in 23,766 of these ginneries; water power in 1,544; gasoline power in 806; animal power in 199; electric power in 116. There were in addition 238 establishments where Sea Island cotton was ginned by other than saw-gins.

TRANSPORTATION IN ITS RELATION TO THE COTTON INDUSTRY

BY W. W. FINLEY

Industrial and commercial development in all ages and among all peoples have been dependent on transportation. It is impossible to conceive of human existence, even in a most primitive state, without transportation. The man of the Stone Age carried to his cave the meat on which he fed, and the skins which made his bed and clothing. Each step of his advance in civilization has been made possible only by a corresponding expansion of transportation. As communities developed, it was found that certain individuals were more successful in producing certain things, and specialization of industries had its first rude beginnings and commerce in the form of barter. Owing to differences in climatic conditions and the distribution of natural resources, it was found that certain industries were peculiarly adapted to certain localities. This resulted in the gradual growing up of a system under which there were produced in different localities more of certain commodities than were needed for consumption in those localities, and commerce between communities began. From those early beginnings, when goods were carried on the backs of men, in rude canoes, or on pack animals, and when commodities were exchanged directly for other commodities, there has been slowly developed through succeeding centuries our present system of world-wide commerce, without which our present high level of civilization would be impossible. This commerce is carried on by a system of transportation which places at the command of the people of each community the products of the world.

To no line of human activity are the adequate and efficient transportation facilities more essential than to the cotton textile industry. Cotton is the most widely used of all the textile fibres. Man has been defined as a clothes-wearing animal, and, in the manufacture of clothes, no other material is so largely used as cotton. This fibre, which is in universal use wherever human beings live, cannot be produced at all in many localities, and can be produced most advantageously only in certain comparatively restricted regions. Leaving aside the comparatively small production of China, South and Central America, the West Indies, and other localities where cotton growing has been attempted, the commercial crop of the world is produced by the United States, India, and Egypt, and whatever may be the future of the efforts being made to extend the cultivation of cotton

in other regions, the world must now, and for the immediate future, depend for approximately sixty-five per cent of its cotton fibre upon the Southern section of the United States.

The universal character of the demand for cotton fibre and the comparative restriction of the localities in which it can be successfully produced make the industries of the production of this fibre, its preparation for use, and its distribution, peculiarly dependent upon transportation. Transportation enters into the production of a piece of cotton goods even before the seed in planted in the ground, for, except in the Nile Valley and a few other localities especially favored by natural conditions, the use of fertilizers is essential to successful cotton production, and transportation is essential to the distribution of commercial fertilizers. Following the production of the crop, the seed cotton must first be carried to the gin, from thence the seed is carried to the oil mill, and the lint to the textile mill, either directly, or after having first passed through the compress. To trace the lint cotton through all of its various stages of manufacture into articles for final use, and to trace the distribution of these articles would involve an account of the transportation system of the world, embracing every means of water carriage on ocean, lake, river, and canal, every railway line in every country, and every wagon road and pack train route throughout the world. Adequately to perform this task would require years of labor and the results would fill volumes. Within the scope of a single chapter little more can be done than to consider, in a broad way, the interrelations of the cotton textile and transportation industries.

As the principal region of cotton production is in the Southern section of the United States, we are chiefly interested in the development of transportation in its relation to the American crop.. Prior to the invention of the cotton-gin, the commerce of the Southern section of the United States was confined almost entirely to localities bordering on the seacoast and the navigable rivers. Shipments from Charleston, which was the most important port on the southeastern coast, were composed principally of lumber, naval stores, rice, and Sea Island cotton, all products of the coastal plane and the adjacent islands. In a general way similar conditions existed at each of the other South Atlantic and Gulf ports, the commerce being only such as could be collected by coastwise and river navigation. Following the invention of the cotton-gin and the rapid development of the Upland cotton industry in the Piedmont Belt, extending from Southern Virginia to Central Alabama and in Western Alabama, Mississippi, and Louisiana, there was a radical change in agricultural conditions and a need of increased facilities for transportation. The annual production of cotton, which in 1790 was equivalent to 3,138 bales of 500 pounds each, increased rapidly to 73,222 bales in 1800; 177,824 bales in 1810; 334,728 bales in 1820, and 732,218 bales in 1830.

The principal market for cotton was in England, with some demand

in New England, where at least one mill had been established five years before the invention of the cotton-gin, and where the industry began to thrive about the beginning of the nineteenth century. To reach either market, cotton from the interior had to be carried to the coast. (See Plate 3.) In the western section this was a comparatively easy matter, for the lands adjacent to the river courses had been first settled, and that section was plentifully supplied with navigable streams flowing directly to the Gulf or to the Mississippi. It was in the eastern or Piedmont Belt that the need of improved transportation facilities was most felt by the cotton growers. Most of the streams flowing into the Atlantic were shallow, and in no case were they navigable into the Piedmont section. Before the construction of railways the problem of the cotton planter of the Piedmont section was to get his product to the head of navigation. As the season for marketing was during the late fall and winter, when draft animals were not needed on the farm, long wagon hauls were practicable, but as late as 1818, Colonel Abraham Blanding estimated that two-thirds of the market crops of South Carolina were produced within five miles of some river on which, at least, down-stream navigation was possible, and that practically all of the remainder were produced within ten miles of such streams.

Various expedients for carrying cotton to the ports by the river ways were resorted to. A distinct type of boat, known as the "cotton-box," was developed. This was a flat boat with high sides, which, when it had been filled with cotton, was floated downstream, and at the end of the down trip was sold for lumber. Steamboats were early introduced on the Southern streams, on those of the Western cotton belt and on some of those flowing into the Atlantic, notably on the Savannah River below Augusta, were highly efficient. (See Plate 3.)

The establishment of steamboat navigation on the Savannah hastened the construction of railways which were to prove the ultimate solution of the transportation problem of the cotton belt. The people of Charleston saw trade being diverted more and more to Savannah by way of the river. After various other plans had been tried, they undertook what was then the bold experiment of attempting to divert traffic from the head of navigation in the Savannah to Charleston by railway. The result was the construction of the railway from Charleston to Hamburg, which when it had been completed for its entire length of 136 miles in 1833 was the longest railway in the world. The success of this enterprise was soon followed by the construction of other lines, and railway development in the South continued until the devastating Civil War arrested Southern progress for the time being. By 1860 the Southern States had the skeleton of a relatively complete railway system, which afforded reasonably satisfactory facilities for the commerce of that period.

From 1792 until the war period, and to a less extent for two decades after the close of that conflict, the economic development of the South was

dominated by cotton. The profits that could be realized from the production of this great staple led to the neglect of other forms of agriculture, and little progress was made in manufacturing of any kind. The people of most communities concentrated all their energies on the production of cotton, with the proceeds of which they bought not only manufactured articles, but food stuffs which, under a more diversified system of agriculture, they would have produced at home. The consequence was that the transportation problem of the South at that period was the carrying of cotton to the seaboard and the carrying into the South of food stuffs and manufactured commodities produced in other localities. Hence it was that the earliest Southern railways led from the cotton fields to the seaports and river towns, and that they were soon supplemented by lines from the North and Northwest by way of the Tennessee and Shenandoah Valleys. (See Plate 3.)

The application of steam to ocean navigation played an important part in shaping the course of cotton traffic on land as well as on water. Steam made the mariner independent of the ocean currents and the winds, and gave to the shorter routes advantages they had never had before. The effect was to increase the relative importance of the North Atlantic ports of the United States as compared with those of the South Atlantic and the Gulf, and when rail facilities became available, a larger proportion of the transatlantic cotton traffic was carried through Norfolk, Baltimore, Philadelphia, and New York. In later years Southern ports, notably those of the Gulf, in close proximity to the Central and Western cotton fields, have been regaining much of the ocean traffic.

Economic conditions in the cotton belt, prior to the beginning of the industrial development and the greater diversification of agriculture, which began about 1880, were, in some respects, very unfavorable to railway construction and operation. Owing to the sparseness of population in most localities, passenger traffic was generally unremunerative, and, on many of the roads, freight traffic was confined almost entirely to cotton and to the relatively small quantities of commodities required for consumption along their lines. On these cotton-carrying roads there was a great rush of business for a few months and stagnation for the remainder of the year. They were compelled to look for their revenues to the traffic hauled between September and January.

The industrial awakening of the South, about two decades after the Civil War, led to important changes in the relation of Southern transportation lines to the textile traffic. Railways which had theretofore been simply carriers of cotton became carriers of cotton goods and other manufactured commodities as well. Although cotton manufacturing had been carried on in the South as a household industry from a very early day and a mill was put in operation near Statesburg, S. C., in 1790, it was not until the decade between 1880 and 1890 that the real development of the Southern

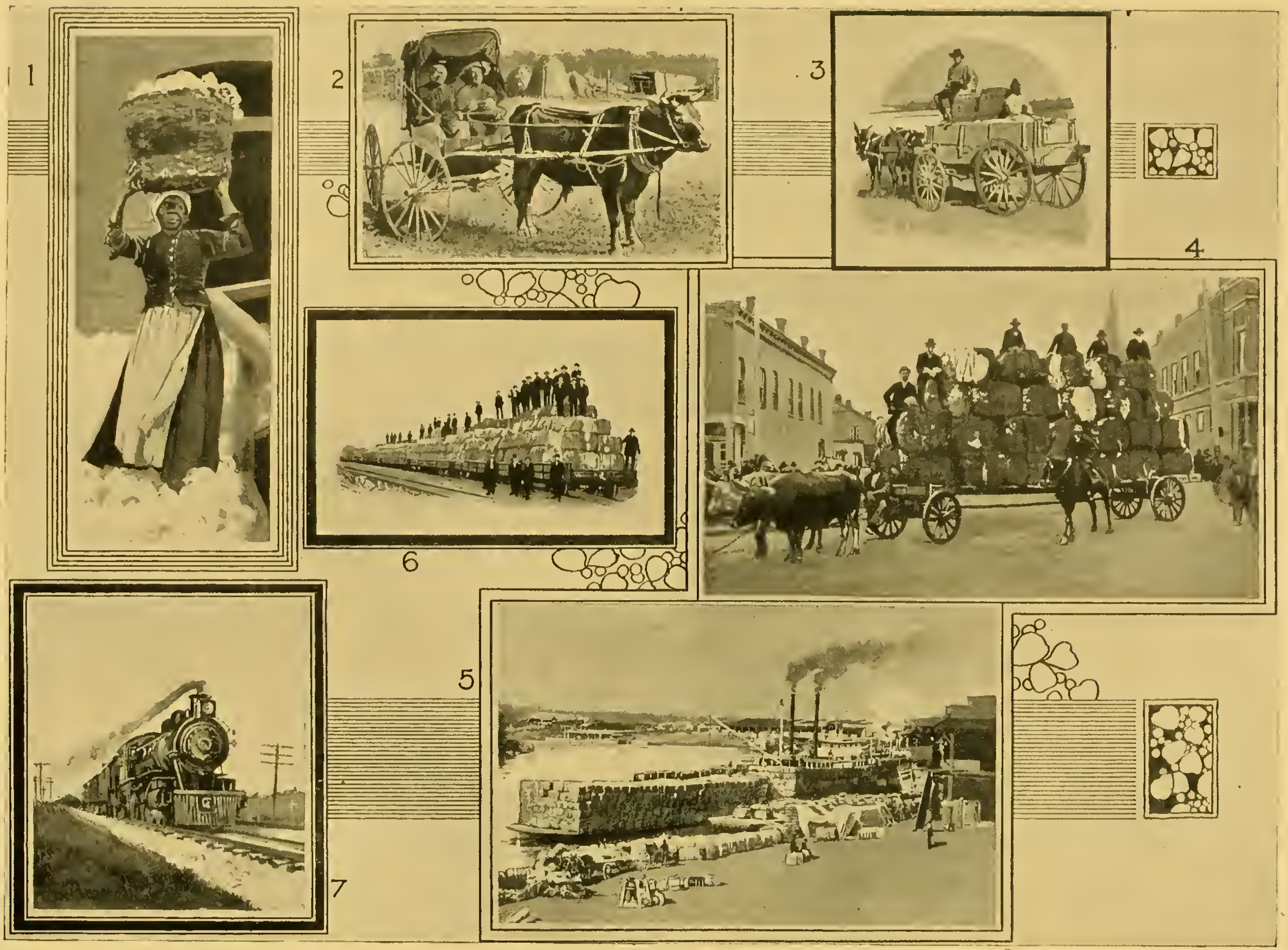
cotton textile industry began. From that time on the economic law which tends to concentrate manufacturing in proximity to the sources of raw materials, has been working for the Southern mill industry, and it is inevitable that sooner or later, if Southern supremacy in cotton production is maintained, the greater part of the world's supply of coarse cotton goods and a large proportion of the finer goods as well, will be manufactured in the Southern mills.

As recently as 1880, the consumption of Southern cotton mills amounted to but 188,748 bales, equivalent to only a little more than three per cent of the American crop of 5,755,359 bales produced in that year. In 1907, the Southern mills consumed 2,410,993 bales, equivalent to more than eighteen per cent of the crop of 13,305,265 bales produced in that year. In addition to Virginia, where the total production in 1907 was but 14,602 bales, while the mill consumption was 68,668 bales, North Carolina, one of the distinctively cotton States, has become a net importer of cotton—the mill consumption in 1907 having been 770,275 bales, and the total production of the State 626,642 bales. On the basis of the figures for 1907, about eighteen per cent of the American crop is consumed in the cotton-producing States; about the same amount is used by other mills in the United States, and the remaining sixty-four per cent is exported, going chiefly to England and Continental Europe. The future may be expected to see an increase in the proportion used in the cotton States and decreases in the proportions shipped to other States and exported.

The development of the textile industry in the cotton States has necessarily resulted in radical changes in the volume and direction of currents of traffic. In the early days the movement was practically all from the interior to the South Atlantic and Gulf ports, and thence by sea to Europe or New England. Later, with the construction of North and South railway lines, there came about a rail movement to the more northerly ports and direct to northern mills. These movements still continue, but they are now crossed in every direction by cotton moving to Southern mills. This movement to Southern mills is more complicated than might be supposed, for the reason that, generally speaking, a mill is not able to secure all of its cotton in its immediate neighborhood. While, in the aggregate, a considerable amount of cotton is sold directly from the plantation to a nearby mill and is not hauled by rail until it has been made up into yarn or cloth, the requirements of mills for particular grades of material are such that a mill in North Carolina, for instance, may buy cotton produced in Alabama or Texas, while cotton produced in its immediate locality may be shipped to some other State or to Europe. Mills in Upland cotton regions may require for the particular class of good they are making, a certain proportion of Egyptian cotton, or Sea Island cotton, and thus cotton produced in widely separated localities may finally meet in a single piece of goods.

Changes in economic conditions and in the centres of manufacturing,

PLATE III—Transportation



1. A Cotton Transporter.
2. Primitive Pleasure Riding.
3. Advanced Method.
4. Reducing the Stock.
5. New Orleans Steamer Landing Cotton.
6. Freight, Cotton Transportation.
7. Train of Fifty Cars.

JAMES H LAMB CO.

have brought about changes in the currents of traffic in cotton goods as well as the raw material. As the manuacturing industry in Europe, and especially in England, antedated the development of production on a large scale in the United States, it was inevitable that the established industry should hold the market, and hence, just as the traffic in raw cotton centred toward the European mills, the currents of traffic in manufactured goods diverged from these mills. Thus as late as 1859, the last year before the Civil War period, we find that exports of cotton were equivalent to 3,535,-373 bales on the basis of 500 pounds to the bale, while consumption in the United States amounted to only 845,410 bales.

The first effect of the rise of the New England industry was to reduce the volume of imports of the coarser grades of cotton goods. As the New England industry grew, it supplied constantly a larger percentage of the domestic demand, not only for coarse goods, but for finer grades as well, and began to compete in foreign markets. Then came the Southern industry, competing first in the domestic market for coarser fabrics, but soon invading the export field and following the example of New England by taking up the manufacture of finer goods as well. This tendency of the Southern mills to manufacture finer goods is shown by the fact that the amount of fine yarns spun by them increased from 886,200 pounds in 1900, to 17,858,453 pounds in 1905.

The growth of the cotton mill industries of the Northern and Southern States and the diversification of their products, has been reflected in the transportation of cotton goods. The currents of traffic still flow from European mills in constantly greater aggregate volume, though in some directions the flow has been diminished and they are now crossed in all directions and met in the markets of the world by currents of traffic from both the Northern and Southern sections of the United States, and in some of the Oriental markets are meeting with an increasing output from the mills of India and Japan.

Just as the growth of the Southern manufacturing industry has profoundly affected the transportation of raw cotton, so has it affected the domestic transportation of cotton goods. Prior to the time when the Southern mills became a factor in the situation, the lines of traffic in the United States were from the Eastern manufacturing centres and the ports, to the interior. Movements from Southern points, either for domestic consumption or for export, were inconsequential. All this has now been changed, and, although there is still a large movement into the South of foreign and domestic goods, and even a return movement of Southern goods shipped back to the South after having been bleached and finished in the North, this is of small proportions in comparison with the large and steadily increasing movement of the products of Southern mills to domestic markets and to the ports of the Atlantic, the Pacific, and the Gulf for export.

The demand for cotton goods is increasing not only with the increased

population of the world, but also with the advance in the standard of living which is slowly, but surely, taking place in many regions as a result of higher civilization and more stable political conditions. The cotton planter of the United States, with such assistance as other regions may be able to give him, is capable of keeping pace with this demand. It is the task of those of us who are engaged in the business of transportation to carry the raw cotton to the mill and to carry the finished product to the uttermost ends of the earth on such terms that cotton fabrics shall be within reach alike of the lady of fashion, who pays at the rate of twenty dollars per pound for Swiss embroideries, or the Manchurian peasant, who pays at the rate of twenty cents a pound for the material for his clothing.

COTTON SPECULATION IN AMERICA

BY CARL GÉLLER

Real estate speculation flourished in ancient Greece and Rome. Forestallers in grain and flour have amassed fortunes ever since the days of Joseph in Egypt. Spices were "cornered" in the Middle Ages. South Sea and Mississippi stock were the basis of furious speculation early in the eighteenth century. Cotton speculation, on the other hand, is barely a hundred years old, but during those hundred years more venturing has been done on the rise and fall in prices of this staple than of any other commodity. Long before the "futures" system was introduced, cotton furnished sport for daring operators and merchant princes. Of course, when the cotton crop amounted to only a million bales or so, speculative "lines" did not run to half a million bales, as they frequently have done since 1890, but relatively speaking, a venture of ten thousand bales some ninety years ago was as momentous an undertaking as twenty times that amount would be nowadays. If a venture pans out badly now, the operator can shift his burden by covering himself in other options or markets. Such facilities were nonexistent before the Civil War, and only a mighty deep purse could save a man if he found the market going steadily against him. This accounts for the enormous fluctuations in cotton prices recorded within a very few weeks, often within a couple of days, in times gone by.

It may be worth while chronicling a few of the more important events in the reigns of the various American cotton kings.

Very little is known about the pioneers of the American cotton trade. In the eighteenth century it was the custom to consign cotton along with other products to London, Liverpool, Havre, and Hamburg merchants, who remitted the proceeds in manufactured products of their countries. In the second decade of the nineteenth century there appears upon the scene a merchant who may fairly be considered the prototype of the modern cotton speculator. His name was Vincent Nolte. Of German descent, though born at Leghorn, in Italy, he acquired his mercantile training at Leghorn, Hamburg and Nantes. Quite early he was thrown in contact with the leading commercial spirits of that period, and, being possessed of great self-reliance, business ability and a thorough knowledge of modern languages, he was entrusted while still a young man with the management of extensive financial ventures; for instance, the transfer of large quantities of silver coin from Mexico via the United States to Eng-

land, a risky undertaking in those troublous times. He acquitted himself to the satisfaction of his principals and his share of the profits enabled him to make a start on his own account. In the course of his travels, in 1806, he had visited New Orleans and resolved to settle there, returning late in 1811. Nolte's arrival at the Southern port coincided with the outbreak of hostilities between this country and England. Although the war checked trade, Nolte found plenty of outlet for his venturesome spirit. The English had blockaded the mouth of the Mississippi, and cotton stored at New Orleans was a drug in the market. Nolte bought 250 bales of cotton at 11 cents per pound and brought them on a small craft through Lakes Borgne and Pontchartrain and Mobile Bay to Pensacola, where he sold the cotton at 22 cents, investing the proceeds in woolen blankets which he sold on his return to New Orleans at a splendid profit. During the defence of New Orleans it was found difficult to properly mount heavy cannon on the marshy ground around the city and recourse was had to platforms of cotton bales. A cargo of 245 bales of good cotton belonging to Nolte was confiscated for that purpose by General Jackson. Nolte. who had enlisted as a volunteer, protested against the use of this good cotton when plenty of low-grade cotton could be had in the city at much lower prices, but was told that as it was his own cotton, he at least would think it no hardship to defend it. Although he had bought the lot a short while before at 10 cents, his claim at that price was rejected, because on the morning of the battle a New Orleans broker had sold him another lot of good cotton at 7 cents, the owner anticipating the defeat of the American troops and fearing to lose everything in the sack likely to follow the capture of the city. General Jackson had heard of this transaction and decided that 7 cents was the market price at which Nolte should be indemnified. The defeat of the English showed Nolte's good judgment, and three days later a vessel brought news of the treaty of Ghent and the end of the war. At one bound cotton prices jumped to 16 cents, and finally the indemnity commission passed Nolte's claim for the 245 bales at 10 cents. He tells us that some of the French settlers, weary of war times and desirous to spend their declining years in peace and quiet at home, now took opportunity to leave New Orleans. As no exchange was to be had, they invested their savings in cotton, which cost them about 12 cents per pound. The freight to Havre amounted to 7½ cents per pound.

From 1815 to 1817 Nolte was in Europe extending his business connections among the French and English cotton importers. During his absence several competitors arrived at New Orleans from Europe, notably two Scotch houses who exported raw cotton and imported manufactured goods, principally Manchester and Glasgow cotton goods: They were clannish, worked together, and, being in close touch with the English markets, often used their superior sources of information to spread un-

favorable news about the state of the British cotton trade whenever they felt like buying or wished to scare away intending purchasers of cotton. During his stay in England, Nolte had come to the conclusion that cotton was bound to advance in value, and immediately on his return bought heavily. Shortly afterward the Scotch houses also began to buy, notwithstanding the pretended "bearish" news they had from home, and Nolte made a handsome profit on his purchases. Step by step his position in the market became more influential. He was the first one to send out printed advices on the cotton market and the crops, accompanied by diagrams of the course of prices from week to week, the variations of the rate of exchange being shown in a different color. These tables proved a great success and brought Nolte many orders from Europe. On an average he bought 18,000 bales a season, as compared with some 7,000 bales bought by his competitors, but during the season of 1820-21 his shipments rose to 40,000 bales, the greater part of which he had bought quietly before the other New Orleans buyers were aware of the fact. As prices rose sharply, his heavy purchases turned out very profitable, and these fortunate results induced many of his French correspondents to entrust him with large discretionary buying orders. With the prospect of a good demand from England, the shipping season in 1821 opened at 20 cents, as compared with 16 cents the previous year. The crop was, however, a large one, and prices quickly declined so that his purchases on reaching Europe showed a heavy loss. A great deal of the cotton bought on discretionary orders was thrown on Nolte's hands and the drafts were allowed to go to protest. In the autumn of 1824 the Liverpool cotton merchants anticipated a considerable advance in cotton prices. The speculative fever was in the air. All sorts of financial schemes were launched and found ready subscribers. Havre experienced a cotton corner, the entire local stock of 10,000 bales having been bought up by one dealer. It is worthy of note that one of the leading Liverpool firms, the Quaker house of Cropper, Benson & Co., at that time issued a circular predicting small cotton crops henceforth, in consequence of the abolition of the slave trade and the probable annual decrease of the colored population of the Southern States. Late in 1824 the surplus of stocks resulting from previous large cotton crops had been absorbed by the mills, and much anxiety was felt in Liverpool concerning an early arrival of fresh supplies from the United States. Nolte was in England in the fall of 1824, and on his return to New Orleans he found that instead of an export of 150,000 bales during October and November, 1824, on which Liverpool had relied, scarcely 30,000 bales had been shipped, and not more than 20,000 bales could possibly be exported during December. In anticipation of higher prices, Nolte bought at once 5,000 bales, and when on February 14, 1825, he received the news of the close of the Liverpool market on December 21, 1824, with an order to buy 10,000 bales, he was

amply prepared. Liverpool had risen one penny when the inadequacy of the local stock had been ascertained and New Orleans jumped 3 cents on receipt of the Liverpool mail. On the lot of 5,000 bales so judiciously bought, Nolte made a profit of $60,000, and on one consignment of 950 bales he gained $55,000. Prices in England rose 110 per cent, but spinners curtailed their purchases and fell back on their reserve stocks, which proved far heavier than the Liverpool merchants had anticipated. Brazil, which did not as a rule ship more than 175,000 bales a season, all at once doubled her exports. There was a deadlock for a time; importers and merchants held firmly to their price, and spinners kept out of the market. In May, 1825, a Glasgow house received 5,000 bales from New Orleans and determined to offer the entire quantity for sale. The Liverpool merchants implored them not to sell below the price set by the "bull" clique, but deaf to their entreaties the Glasgow people sold the 5,000 bales at a concession of 2½ pence per pound. The bubble burst and prices declined rapidly, the more so as the new crop proved to be unusually large. Nolte was entangled by engagements not to sell his cotton stored at Liverpool without the consent of his English friends. Shortly before the collapse he had sold 6,000 bales to a Charleston dealer. The promised remittance failed to come, and when in Liverpool cotton prices tumbled from 16 pence in April to 9¼ pence in July, causing the suspensions of many of his Liverpool friends and also of his Charleston correspondent, Nolte failed with liabilities of $1,200,000. During the next few years he was engaged in winding up his affairs and spent most of his time in Europe. At one time he did a profitable business in supplying arms to the French militia, thanks to his friendship with Lafayette, whose acquaintance he had made in America. Some twelve years later he returned for a brief spell to the cotton market, but the chief part was then played by another man, Nicholas Biddle.

Biddle's operations in the cotton market are not so well defined as were Nolte's. In the main, Biddle was a financier and his connection with the cotton market arose out of his intimate relations with the Southern State authorities and banks.

Biddle was president of the Bank of the United States, of Philadelphia, the foremost banking institution of the country. It had formerly been under Federal charter, but incurred the enmity of President Jackson, who persistently vetoed the renewal of the charter. The bank therefore continued under charter of the State of Pennsylvania. Interstate business was denied the bank, but it managed in various ways to meet the difficulty. It largely invested in Mississippi State bonds issued in 1831 and 1833, to form the stock of the Planters' Bank. To other Southern banks it furnished the entire capital.

Early in the thirties a land boom swept over the United States, the like of which has never been seen before or since. It affected the South particularly and caused the rapid settling of Mississippi, Louisiana and Arkansas.

Young cotton planters migrated to the Southwest from Virginia and the Carolinas, with gangs of slaves from their paternal estates. They largely depended for financial aid on the banks, and thanks to the backing of the great Philadelphia institution there was no lack of banking facilities. Mississippi alone increased within five years her nominal banking capital from $1,000,000 to $21,000,000. The credit system was carried to an extent that can now scarcely be credited. Men with very little capital bought cotton plantations and slaves and drew on their bankers immediately against the yield of the first crop, before the seed had been sown. As long as cotton prices remained highly remunerative, everybody made money, but when the turn of the tide came, the strained credit of the South collapsed like a house of cards. The reaction came in the spring of 1837. Cotton declined quickly from 17 cents to 10 cents, and bankers and brokers who had made large advances to the planters were the first to suffer. Nine-tenths of the mercantile firms of Mobile failed. In New Orleans, every house of importance went down and cotton became almost unsalable. Biddle's bank was hard hit, but weathered the storm, and he did his utmost to revive the moribund banking institutions of the South.

Through his intimate connections with the South, Biddle had a vital interest in the great Southern staple, and noticing the ever-increasing cotton consumption in England, he argued that it would only be necessary to market crops judiciously, buying up and storing any troublesome surplus, in order to create a practical monoply and obtain good prices. In the autumn of 1837, he sent representatives to Charleston, New Orleans and other Southern markets to purchase enormous quantities of cotton for account of the Bank of the United States, for shipment to Liverpool and Havre. His eldest son, a youth of twenty years and an old unsuccessful Philadelphia merchant, May Humphreys, he sent to Liverpool to sell this cotton. The new firm, Humphreys & Biddle, though without knowledge of the English cotton trade, at once obtained a larger share of the business than the Browns, Barings, Lizardis or any other of the old-established and substantial houses of that great cotton mart. In Havre, his consignees were the large banking and commission firm of Hottinguer & Co. By granting facilities to Southern banks, he induced them to make liberal advances on cotton and to ship a large portion of it to his son's house in Liverpool. This enabled him to control the cotton market in this country and to carry out the principle of monopoly. The first year this colossal undertaking prospered and Biddle decided to extend it; in fact, he was obliged to do so if he wished to maintain the monopoly. He found it necessary to strengthen the Southern banks which had, as his indirect agents, induced the planters to send their cotton for sale to Liverpool, the advances being made in depreciated paper. What Southern banks had survived the crash of 1837 were badly crippled, and in the summer of 1838 their paper had fallen to a discount of 25 to 30 per cent. It was clear to Biddle that the Southern banks could not obtain control of

the new crop unless they were enabled to resume specie payment and raise the value of their paper to par.

Under ordinary circumstances, foreign merchants and capitalists would have flocked to the South and purchased the cotton at a low price, considering the advantage cash would have given them over the depreciated Southern paper. By throwing the cotton on the Liverpool market, they would have lowered the price and interfered with Biddle's idea of prolonging the monopoly. Accordingly, Biddle in August and September, 1838, commenced rebuilding the Southern banks that had engaged in the cotton trade, and he purchased the bonds of others to enable them to go into the operation. Biddle and a few of his Philadelphia friends, principally the officers of the Girard Bank, began buying enormous amounts of Southern State and bank bonds. In one week they invested about $10,000,000 in the State of Mississippi. Half of this sum was distributed among four insolvent banks at a nominal interest of 7 per cent, the principal to be repaid in three annual instalments. These banks were the Commercial and Railroad bank of Vicksburg, the Planters', the Agricultural and Commercial Bank, of Natchez. It is said that before purchasing the bonds of these banks, Biddls and his associates had bought up an immense amount of their notes at 28 per cent discount, and in the bolstering operation they used this paper at par. The other five millions were invested in Mississippi State bonds, to establish the Union Bank of Jackson. This new institution soon flooded the country with its paper and advanced as much as $60.00 per bale (of 360 lbs.) or almost 17 cents per pound, when the average price in New York during the previous season had not been much above 10 cents. It is true, the 1838-9 crop was decidedly a short one, furnishing only 1,360,000 bales as against 1,800,000 bales the previous season. Much of the large 1837-8 crop had been held back by Biddle, his operations extending throughout Louisiana, Mississippi, Georgia, Alabama and Arkansas. In view of the threatened shortage, it seemed that he would be able to market at very remunerative prices not only the 1838-9 crop, but also the balance held back out of the previous one.

Here again our friend Nolte appears on the scene. Rich in experience but poor in worldly goods, he had returned to the United States and in New York met the representative of Biddle's Havre correspondents, a friend of his. Thinking that with his knowledge of the New Orleans market he might be useful to Biddle he obtained a letter of introduction to the great financier. Biddle received him well, but would make no change in his New Orleans arrangements, offering, however, to extend to Nolte banking facilities if he wished to start again on his own account. Early in 1839 Nolte arrived at New Orleans and awaited reports from his English friends, the Barings. The English cotton trade had expected that the 1838-9 crop would be quite as large as the preceding one, about 1,800,000 bales, but Nolte soon saw that it would be much less. At the end of 1838 the Liverpool stock was reduced

to small proportions, and the size of the crop as well as the policy of the U. S. Bank party were of the utmost importance. It looked as though Biddle had attained his object of an extension of the monopoly and Nolte as well as his English friends were hopeful of a quick and decided rise in prices. Nolte made a start by buying 1,000 bales, although his cash capital amounted to less than $500. He continued buying and shipping cotton for the Barings and Browns, of Liverpool, Denistouns, of Glasgow, and Hottinguers, of Havre, and within a quarter of a year he had handled 37,000 bales. In the meantime, the market, instead of advancing, had persistently declined, due to the disinclination of the spinners to buy. Seeing this, the Bank party preferred to take no chances and offered its cotton freely. It was the old story: mills had been buying liberally when cotton was much cheaper and they now fell back on their reserve stocks. Consumption was checked by the high prices of breadstuffs on account of the short grain crops of 1838. Within a few months, Nolte again found himself in difficulties. The cotton shipped to Europe on consignment could not readily be sold, or only at a heavy loss, and remittances came in slowly. Nolte was imprisoned for debt, but soon released, and at once left New Orleans forever. On his return voyage to Europe he met a rich South Carolina planter, General Hamilton, a friend and admirer of Biddle's. Hamilton had conceived the idea of forming a board of information at some central point in the Southern States whose duty it would be to keep in touch with the condition of the European markets, consumption, stocks, etc., and also to finance the cotton crops of the planters. The American members of the Association should be kept informed as to the relative value of cotton, and those that were not willing to sell at the market price should receive advances and entrust the sale to the foreign agents of the board. By such means General Hamilton hoped to make cotton prices steady and remunerative. He took a liking to Nolte and offered him an important position on the board, but just when Nolte was ready to return to America in furtherance of this new project, his friends, the Hottinguers, of Havre, informed him that they would let a draft of the U. S. Bank for 6,200,000 francs go to protest. This was the beginning of the end of Biddle's bank and his vast schemes. The Bank soon failed, carrying down all the banks in Pennsylvania and south of that State. The Liverpool offshoot of the Philadelphia concern, the firm of Humphreys & Biddle, closed its affairs and the two members returned to America with large fortunes.

The following decade witnessed a steady increase in cotton production, which soon outstripped consumption. The natural result was a decline of cotton prices to very low and unremunerative figures. The average price for the season 1844-5 was only 5.63 cents in New York, and another low level was seen in 1848-9, in consequence of the political disturbances in Europe. With the discovery of gold in California and Australia, a general trade revival set in, which lasted until the beginning of the Civil War,

enhancing cotton prices and improving the lot of the sorely-tried cotton planter. Late in the fifties, consumption had again outgrown production, and English spinners became anxious about a sufficient suppply of raw material. The Manchester Cotton Supply Association was formed, and seed, tools, gins, instruction and teachers were sent to every likely and unlikely corner of the earth. It is an interesting question whether this expensive propaganda would have achieved any results worth mentioning but for the cotton famine caused by the Civil War. The fact that with the return of normal conditions in the South these schemes utterly failed everywhere should answer it negatively.

During the Civil War, individual speculative deals in cotton were quite common, but the enormous fluctuations, extending at times to fifty and even sixty cents per pound in a single fortnight, limited cotton speculation to comparatively small quantities. At this time, "futures" were first introduced, as the mills were unwilling to run the risk of the tremendous price fluctuations. They bought certain quantities of cotton at a determined price for delivery at stated later periods, and the New York brokers who sold them the futures had to cover their risk in other directions, either by securing the spot cotton or by buying futures from other brokers or operators. These transactions were, however, merely private deals, were not officially recorded and did not attain great importance, but the fact remains that the "futures" system owes its inception to the time of stress and uncertainty during the Civil War.

During the entire war, there were several million bales of cotton locked up in the South, where it was a drug in the market, while in the North and in Europe it commanded fabulous prices. Blockade running became a very profitable, if risky, business. A good deal of cotton ran the blockade from Charleston, Mobile and Wilmington to England via the Bermudas, and during the years 1862, 1863 and 1864, some 400,000 bales of American cotton managed to get into Liverpool. In the early stages of the war, many thousand bales were shipped from Liverpool to New York. In 1863, the Confederate Government placed a loan of £3,000,000 in England, paying seven per cent interest. It was readily subscribed, because any bondholder could, by giving sixty days' notice, demand the payment of his bond in cotton at sixpence per pound delivered in the interior of America, within ten miles of a railroad during the war, and on consummation of peace at one of the Southern ports. The value of this Confederate stock to an English cotton merchant can easily be understood. The bonds could soon be bought at a discount of fifty per cent which reduced the purchase price of the cotton to threepence. Fitting up a ship with manufactured goods and running the blockade into one of the Southern ports, the English merchant could sell his goods at an enormous profit, claim his cotton for the face value of the bond, reload his ship with cotton, and if he was successful in running the blockade outward, he could sell his cotton at a profit of 600 to 800 per

cent. It was said that the capture of seven vessels would not cause loss, if the eighth vessel were successful. Toward the end of the war, the gradual advance of the Federal lines opened up some cotton territory and released the cotton stored there. Each Northern victory was therefore followed by a sharp slump. Sherman's march from Atlanta to the sea caused cotton to drop from $1.80 to $1.00. The late Edward Matthews, father of Professor Brander Matthews, of simplified spelling fame, had the happy faculty of getting cotton through the lines wherever the Union army advanced. The Federal Government did not look with favor on this cotton traffic. It put money into the hands of the South, whereas it was Northern policy that cotton should remain a useless commodity while it stayed in the South. Charles A. Dana, later the brilliant editor of the New York "Sun," entered into partnership with Roscoe Conkling toward the close of 1862 for the purpose of buying cotton in such parts of the Mississippi valley as had been occupied by the Union forces. He soon became convinced, however, that to permit the purchase of cotton within military lines was bad for the Federal Government and should be stopped. He pointed out that the mania to acquire sudden fortunes by cotton speculation had already to an alarming extent corrupted and demoralized the army, and he urged President Lincoln and Secretary of War Stanton to put an end to the cotton traffic within the military lines. The close of the war released some 2,500,000 bales of cotton held in the South, worth about $400,000,000. About three-quarters of this amount was taken by Europe and gave this country the value of $300,000,000 in gold. The liquidation of this valuable asset did much to re-establish the shattered credit and finances of the United States.

After the war there followed the dark days of reconstruction. Labor conditions were topsy-turvy, most planters heavily in debt, and the Southern cotton factors bankrupt, almost to a man. The advances they had made just prior to the war to farmers and planters had never been repaid. What financial aid could be rendered, had to come from the North, and in this way New York suddenly forged ahead as a cotton market. A good many Southerners came North and made fortunes. To mention but a few, there were R. T. Wilson, from Tennessee, John C. Latham, from Kentucky, Archibald B. Gwathmey, from Virginia, and John H. Inman, from Georgia. The last named became a power in the cotton trade and cotton speculation. Coming to New York soon after the war with $100 in his pocket, he eventually turned this into $10,000,000. To his career we will revert at greater length later.

The five years after the Civil War were a period of sudden price fluctuations. Advances and declines of five cents in a week were by no means uncommon, and cotton trading and spinning was a very risky business. We have already shown how during the war the system of trading in futures had sprung up. It found ever-widening acceptance, particularly after the organization of the New York Cotton Exchange and the introduction of

regular methods and rules for futures trading. Free use began to be made of the insurance feature of the futures system by the mills, not only in this country but also in Europe. Futures, like everything else, may be put to illegitimate uses, but it is absolutely certain that the introduction of the system has had a salutary, because steadying, influence on the course of prices. With a cotton spinner the main thing is the price of the raw material, but a consideration almost as important is that there be a certain stability of the market which permits him to make his calculations ahead for some length of time. Before the era of futures, an even approximate stability of the market was not to be thought of, but the introduction of futures tended to lessen fluctuations by extending the upward or downward swing over a longer period. If prices are high, there are always cool heads ready to sell for deferred delivery, and when the expected decline sets in, their buying to secure profits tends to hold and steady the market. If prices are low, there are always shrewd men to pick up cotton in the shape of futures, this preventing or delaying a further decline, and on a rise their re-sales act as a brake. Mr. Henry Hentz, one of the oldest and most respected cotton merchants in the New York market, said some time ago: "During 1866 and 1867, before the New York Cotton Exchange was established, cotton dropped from two shillings to sevenpence in Liverpool. The crop of 1867-8 was a very small one, only about 2,500,000 bales, and it was taxed 2 cents a pound by the Government. Now, I say with emphasis, cotton would never have dropped to such a low point—it subsequently advanced to 33 cents in 1868-9—had there been an opportunity for the holders to hedge their holdings by the sale of futures." The futures system enables the planter to sell part or the whole of his crop when the price appears attractive to him, months before his crop is gathered. The spinner can buy his supply for many months to come, whenever the price seems low enough to him, simply by buying futures. He need not even go into the market and exchange his contracts for actual cotton, although he may do so. He can simply regard his futures purchase as an insurance against a rise in the market.

With the return of settled labor conditions in the South, with the gradual cutting up of the large cotton plantations into smaller holdings, with a steady increase in acreage and a gradual displacement of colored by more efficient white labor, production slowly but surely gained on consumption. For a time the trade boom in this country and the crop failure of 1871 held prices steady, but the adoption of the gold standard by Germany in 1873, and other countries subsequently, caused a steady appreciation of gold and a corresponding decline in prices of all commodities. "Sell, even if you have to repent," became the guiding rule for the large New York, New Orleans, Liverpool and Manchester houses, and considerable fortunes were built up through steady adherence to this principle. There was no spectacular speculation in this. It was the steady grinding down of values by the appreciation of gold, incidentally helped by the increasing supply of cotton and by

enormous "short" sales that gathered the golden harvest for large houses, many of whom were ably managed by the keen, calculating genius of the Hebrew race. Their operations were much facilitated by the gradual spread of the futures system. In 1870-1 only 2,500,000 bales were traded in for future delivery on the New York Cotton Exchange, and a great part of this was actually delivered on maturity of the contract. In 1874-5 the sales of futures in New York amounted to 8,357,000 bales, in 1879-80 to 34,000,000 and in 1895-6 to 55,000,000, while New Orleans traded during that season in 15,500,000 bales. The average price declined from 17 cents in 1870-1 to 15 cents in 1874-5, 12 cents in 1879-80 and 6½ cents in 1894-5.

During these twenty-five years some efforts at speculative manipulation were made by several operators. More or less unintentionally, a cotton corner had been brought about early in the seventies by the large manufacturing firm of Garner & Co. Runge, of Galveston, late in the eighties, tried to corner both wheat and cotton, but failed. D. G. Watts and Sol Ranger made a name as successful speculative cotton merchants. Inman was active at times both on the "bull" and the "bear" side, though generally as a "bull," and his operations were keenly watched by the market. It is said that at times his "line" would reach and exceed 500,000 bales, spots and futures.

The first ten million crop, in 1894-5, depressed prices below 6 cents, and early in 1895 cotton had few friends. Inman began buying on a very large scale early in the spring, when spot cotton was selling at about 5½ cents in the New York market. The country was just recovering from the period of financial and commercial depression following the panic of 1893. Inman was one of the first to recognize the change for the better, and to appreciate its importance to the cotton trade. He steadily bought both spot cotton and futures in all markets. He accumulated an enormous line, estimated by many at about one million bales, but after an advance of 2 cents he realized his profit and closed the deal early in June. The market declined slightly, but then a drought began in the South, which turned out to be the most serious in the history of the cotton belt up to that year. It extended from the beginning of July to the early part of October, with hardly any rainfall to relieve it. This cut off the early prospects of the crop from nine and a-half million to eight million by the middle of August and to seven million by the end of September. Encouraged by this virtual crop failure, Peter Labouisse, of New Orleans, started to buy heavily. He had a large and enthusiastic following, mainly in the South. Prices kept advancing and cotton went from 7 cents to 9¼ cents, the bull movement not culminating until the middle of October. Labouisse carried his bull campaign so far and the markets became so congested from heavily overbought conditions, that he was unable to unload and secure his profits. He knew the market would break the moment he tried to do so. He bought as long as he could and his friends followed him, but the crash finally came through attention being

called to the weakness of the speculative position, and when other speculators tried to sell out, a panic ensued which lasted from Friday afternoon until the following Monday night. In less than a dozen trading hours, prices for the various options broke nearly 1¾ cents per pound. Cliques had to be formed in New York, even among the bear element and outside interests to protect the market from running into greater disaster. The stock market, too, was shaken by the collapse, and at New Orleans four firms went to the wall. Labouisse was compelled to retire from business and there were many pitiful stories told of how his sudden reverse and loss of over $3,000,000 in paper profits affected him.

In 1896 John Inman, after many a brilliant and successful campaign, met with defeat. As the supply was small and the prospect for the new crop unusually promising, he bought near options and sold new crop options on a very large scale. At one time, the difference between August, the last old crop option, and October, a new crop option, was about a cent and the "straddle" looked highly profitable. In July, drought set in again and cut the crop off to the extent of a million bales. New crop options gained rapidly on old crops, and toward the end of August, that option was below October. It was reported at the time that Inman had lost a good slice of his fortune. His defeat, which was his first serious one, so preyed upon his mind that his health broke down. He keenly felt the decline of his prestige and the heavy losses of his friends, who followed him in his operations, and was compelled to withdraw from business.

About this time, a new power in the cotton market made its appearance. Theodore H. Price, a Southerner by parentage, a close student of cotton lore and statistics, who had been brought up in the cotton trade in all its ramifications, now began to enter at times into large deals, though his operations at that period cannot be compared in magnitude with his later ventures. Mr. Price, then a member of the firm of Price, McCormick & Co., undertook to gather a large following, and his circulars began to attract general attention, not only in this country, but also in Europe.

The year 1896 marked the lowest point of depression in commodity prices, and from then on the depreciation of gold and the corresponding appreciation of commodity values set in. The Transvaal, American and Canadian mines began to yield an ever-increasing supply of gold, and as by this time most civilized nations had accumulated the gold stocks necessary to serve as basis for the universally accepted gold standard, the influence of the growing gold supply on commodity values was henceforth unhampered. Depressed though prices were by the two enormous crops of 1897 and 1898, the market was able to make a determined stand at 5½ cents and the "bears" could not budge it. Henceforth it has been "Sell and Repent'" with a vengeance for many of the large houses, and a good slice of the fortunes built up by steady and successful short selling between 1873 and 1896 has since been lopped off.

On the two large crops of 1897 and 1898, there followed in 1899 a very short one. Theodore H. Price was one of the first to recognize the crop failure. He started bulling the market in August, 1899, when prices were still around 6 cents, and in spite of the indifference of European markets and London predictions of an eleven million crop, pushed values steadily upward to 7½ cents at the end of the year.

During Mr. Price's bull campaign in the fall of 1899, there happened a tragi-comic byplay which is well worth recalling.

On September 29, 1899, New York had given itself up to the full enjoyment of "Dewey Day." The week had been a strenuous one for the cotton brokers, as between Monday and Thursday, September 25 to 28, cotton had advanced some fifty points. Glad of the rest or respite, as the case might be, many New York brokers had gone to the country. All the other cotton exchanges were open for business as usual. It would seem that the regular staff of the New York office of the Western Union Telegraph Co. had also taken a day off, and a "green" man was apparently entrusted with the transmission of the official Liverpool market cables to New Orleans and the other exchanges. It seems to have been the practice to note each fluctuation, as it was reported from Liverpool, against the closing price of the previous day, but the "green" man added them collectively. Starting with reporting a decline of some 5.64 points, or 15 American points, he soon varied the tune and kept on reporting advances, piling agony on agony for the unhappy shorts until he had managed to gather together an advance of 82½ English points, equal to 250 American points, or $12.50 per bale. New York being closed, New Orleans had all the trading to herself and wild excitement reigned. The surging, gesticulating, shouting, yelling, dishevelled mass of men around the fountain on the New Orleans Cotton Exchange screamed at one another like maniacs, and never in the history of the Exchange have such hair-raising scenes been enacted. The steady advance by jumps of 2.64 points and at times 3.64 points at last aroused suspicion, and the Exchange was closed before the innocent instigator of the excitement had gotten through his entire schedule of advances. Direct communication with Liverpool revealed the fact that very little change had occurred, and all trades done on the basis of the erroneous Liverpool quotations were declared void. Very heavy losses were, however, sustained by some traders, and much confusion and actual damage was caused at the Interior markets which had received the Liverpool quotations via New Orleans, Galveston, Houston, Savannah, Charleston, Augusta, Little Rock, Atlanta, Mobile, etc., had been infected by the sudden bull fever and large quantities of spot cotton were readily bought. The New England markets had received the same erroneous quotations and kept the wires busy with accepting overnight offers from Southern factors which the latter were just as eager to withdraw. The Southern cotton merchants peremptorily wired their interior agents: "Buy cotton." When asked at what price, the

only reply was: "Buy cotton; too busy to talk," and they bought cotton, lots of it. Some of the country buyers sent men on swift horses scurrying along country highways and clearing out crossroad stores of private stocks of cotton, at advances of \$1.00 to \$2.00 a bale. By the time the news came that the Liverpool advance was bogus, these agents were beyond reach and kept hurrying on, buying cotton at a big loss long after their employers knew the story of their undoing. One large Savannah house bought 5,000 bales in the interior at an advance of about \$1.50 a bale. When the mistake was finally discovered, the reaction was equally intense on all the Exchanges. Before the tangle was fairly straightened out, much loss had to be pocketed and a great deal of litigation ensued. But for the prompt action of the New Orleans Cotton Exchange, in suspending the session, losses would have been much greater.

To understand the ready acceptance of the erroneous quotations, it must be borne in mind that traders were keyed up for bullish news. As we pointed out, there had been a good advance in the early part of the week, and it was rumored that Rockefeller had gotten hold of the cotton market.

When Theodore H. Price had put the market up about 1½ cents, he thought prices high enough and early in January, 1900, he not only sold out, but went "short" heavily. For a day or two the market wavered, but the insufficiency of the crop had in the mean time dawned upon the trade and prices moved steadily upward. Price saw his mistake and quickly reversed his position, but a good share of the profits made in the early part of the campaign was lost. Cotton kept climbing until March, when 9⅞ cents was reached. Price was now very bullish, and seemed to intend a May corner, but was unable to stand the strain of the enormous quantities of futures and spot cotton thrown at him, principally by the large Philadelphia house of McFadden. On May 24, 1900, his firm failed with liabilities of \$13,000,000. It was one of the largest commercial failures in the history of the country and will no doubt always remain unique for the fact that within three years, through shrewd and conscientious liquidation of the assets, even the unsecured creditors received 80 cents on the dollar, and were paid in full one year later by Mr. Price, personally and voluntarily. His prediction as to the course of the market in the summer of 1900 was fully borne out by the rapid rise that set in soon after his failure. Where he had left off, two New Orleans operators, W. P. Brown and Frank Hayne, made a fresh start, but they were content with moderate profits and no corner was attempted in this country, although supplies fell to a very low level and many mills had to stop for want of raw material. In Liverpool, however, there was a full-fledged September corner, prices rising about 2½ pence for the September option in less than ten days. The bullish excitement was fanned to white heat by the Galveston disaster and Neill's estimate of a crop of but nine and one-half millions. On September 13th, the bull speculation reached its climax, but so much cotton

was brought to Liverpool from all the other European markets, and even from mills, that soon afterwards the bulls abandoned the corner.

The crops grown in 1899, 1900, 1901, and 1902 were all moderate ones, but production and consumption were so evenly balanced that prices fluctuated little. In 1901 and 1902 Theodore H. Price made several successful turns, and, through the able and lucid exposition of the market position, statistically and otherwise, in numerous circulars regained his prestige as the best-posted cotton man. In the fall of 1902 he engineered an enormous straddle, buying the January option and selling an equal quantity of March cotton. The commitment on each option was about 750,000 bales. For some reason or other, the straddle was not successful and was liquidated in the early part of January, 1903. It is remarkable that the liquidation of these huge amounts of futures was attended by little or no excitement and was accomplished before the market became aware of the fact.

A new cotton king now enters on a brief reign. Daniel J. Sully, of Providence, R. I., had recognized the shortness of the 1902 crop and began buying heavily early in January, 1903. Through persistent buying he gradually lifted prices to 11½ cents in May, when he took his profits and temporarily withdrew from the market, Brown and Hayne, of New Orleans, taking up the bull campaign where he left off. They cornered July, August, and September both in New York and New Orleans. A September corner in this country is of rare occurrence, as generally there is plenty of new crop cotton forthcoming, but in 1903 the crop was exceptionally late. In September, 1903, Sully came back into the market, but met with very indifferent success at first, in fact, it is said that during the decline following the series of corners he lost his entire fortune and had to rely on assistance from a wealthy friend. This decline was, however, short-lived, and an early frost cutting down the growing period of the crop to a minimum, it was soon seen that the crop would be even smaller than any of the three preceding ones. Prices rapidly advanced and soon Sully was again on his feet and pursued his favorite methods of pushing up the market by the brute force of buying huge amounts. At the end of January, 1904, the July option had reached the dizzy height of 17½ cents, which showed a rise of more than 8 cents in less than four months. Sully showed good sense in cleverly unloading on unsuspecting associates and the public, and when early in February he announced that he was retiring from the market for a much-needed rest, prices fell sharply 4 cents within a few days. At one time it looked as though a panic was impending, and Sully's friends prevailed on him to stay and support the market. A fresh advance began which carried prices to within 1 cent of the previous high record. Here Sully's friends and associates turned the tables on him, selling out before he had a chance to realize his paper profits. The selling became universal. Sully found it impossible to stem the tide, after prices had declined 2 cents in three days, and on March 18, 1904, he declared his

inability to meet margin calls. The announcement caused a further immediate break of 2 cents, but heavy purchases by the McFaddens and other shorts steadied the market.

The 1904 crop made an excellent start and as under the stimulus of the very high prices the cotton acreage had been greatly increased, Theodore H. Price early recognized the excellent chances for a bear campaign. No man ever spent as much money on gathering crop information and securing reliable statistics as this indefatigable operator. He became convinced that the crop would exceed twelve million bales and might even reach fourteen million bales, and his enormous short sales netted him a fortune. There was a steady decline of about 8 cents between Easter and Christmas, excepting a brief rise in August engineered by Price himself against the congested short interest. In the spring of 1905 Price turned bull and again had a very successful campaign. His winnings on July 3, 1905, were popularly estimated at a million dollars. In August he turned bearish and conducted a profitable campaign against Dick Brothers, who had tried to run an October corner. For once Price overstayed the market and for a time was a heavy loser, as the 1905 crop turned out to be quite as small as Price had predicted. Still the surplus from the previous enormous crop proved sufficient to satisfy all needs, and with the turn of the year a rapid decline set in. By February, 1906, Price had made good all previous losses and for a time withdrew from the market. In April, 1906, Price started a May squeeze which was fairly successful, but he remained bullish in the face of excellent prospects for the new crops. In August he abandoned his campaign and prices broke sharply.

The brilliant outlook for the 1906 crop was rudely disturbed at the end of September by one of the fiercest tropical storms that have ever swept over the cotton belt. Quantitatively, the loss was not so large, but qualitatively it is hard to estimate. Suffice it to say that the average quality of the 1906 crop was the poorest in many years. It is claimed that in the revision of grades the New York Cotton Exchange did not take sufficient account of the scarcity of good grades, with the result that the difference between Liverpool and New York increased from seventy-five points at the end of October to 200 points in April, 1907. Enormous straddle or arbitrage operations were carried on between the two markets, and it is estimated that at one time this straddle interest amounted to close upon five million bales. The winnings of the successful straddlers, mostly wealthy spot houses, are in the aggregate estimated at $20,000,000.

The start of the 1907 crop was highly unfavorable and as business in all branches of trade and industry the world over was on feverish boom lines, cotton prices rose rapidly. Theodore H. Price, excellently posted as always, was a heavy winner on the bull side, but as a close student of economics he foresaw the gathering of the storm and predicted the panic months ahead. He turned bear in August and again was very successful,

as at the end of October the panic caused a sharp break of prices. The last few months of 1907 saw a remarkable and highly profitable straddle engineered by a number of prominent New York cotton houses, Craig & Jenks being the leaders. They bought the December and sold the January option. In September the December option was ten points below January. During December that option had advanced to a premium of seventy points above the following month.

Early in 1908, Sully reappeared for a short while on the speculative stage, but his success was very moderate. Price also turned bullish on the market, but the after-panic effects, the closing of prominent New York banks, and the general apathy following the speculative carnival of the previous year, all this weighed heavily on the cotton market and carried prices down about four cents between the middle of January and the end of April. Price is said to have lost a great deal of money on his deal and has since then devoted most of his time and attention to the development of a mechanical cotton picker which seems to have solved the thorny labor problem in the South. In May, 1908, Jesse Livermore became active in the cotton market and worked a July corner. On the futures end of the deal he made a good deal of money, but lost heavily on the accompanying spot transactions. He also endeavored to squeeze the August and September options, but was unsuccessful and current gossip credits him with heavy losses on his cotton speculation. The 1908 crop was a very large one and prices declined to eight and a half cents toward the end of the year.

Early in 1909 a new star rose in the speculative firmament. Eugene Scales of Dallas thought that in view of the deficient winter moisture in Texas and the steady advance of the boll weevil the next crop would be a moderate one. It is said that on a diamond ring he raised $400, invested this in cotton and within ten months turned this into $8,000,000. As Scales had expected, the 1909 crop turned out to be small, and in his bull operations he was joined by James A. Patten, the prominent Chicago grain operator, Colonel Thompson, allied with metal interests and reputed to be many times a millionaire, the New Orleans veterans, Brown and Hayne, and some lesser lights. The advance was practically continuous until the end of the year, when an advance of about seven cents had been recorded. The bulls had an enthusiastic following and everybody seemed to look for 20 cents in the near future. Early in 1910 the McFaddens made an eminently successful raid on this congested long interest, and prices declined almost 3 cents in as many days. For a time the market wavered but toward the end of February the old bull clique took hold again and with the help of Southern mills, arranged to take up what spot cotton would be tendered to them in March, May, July and August. The program was faithfully adhered to, in spite of the fact that all the bull leaders were indicted by the Federal Government for violation of the Sherman law. It is an open secret that on the spot end of the deal the losses were enormous, but much

money was made on manipulation in the futures market. The bull campaign culminated at the end of August when that option climbed to 20 cents. There somehow, a hitch occurred, cotton coming out from unexpected quarters. Angry recriminations followed and so far this feature of the bull campaign has not been cleared up.

Herewith we conclude our unpretentious sketch of cotton speculation in America. To an unbiased observer it would appear that whatever has been the ultimate fate of the individual operator, he fulfilled a useful function. Without him the course of prices would have been more erratic and the business of the spinner more uncertain, though this may seem paradoxical. Beyond any doubt, whenever a prominent speculator is successful, he steadies the market, and if he reads the signs of the market wrong, he is generally the heaviest loser.

THE MANUFACTURE OF COTTON

BY E. M. NORRIS

Of the beginning of the manufacture of cotton we have no record. We trace it back to the shadowy ages beyond all chronicles, the age of myth and legend, and there lose trace of it. India was its birthplace, but Hindoo mythology is uncertain, and does not aid us in determining when cotton was first spun and woven there. The earliest mention of it is found in the religious books of the Hindoos, in the Rig Veda, Hymn 105, verse eight, written 1500 years before Christ, in which there is an allusion to "threads in the loom;" and in "The Sacred Institutes of Manu" (800 B. C.), cotton and cotton cloth are repeatedly referred to under the Sanscrit names "Kurpasa" and "Kurpasum," and cotton seeds as "Kurpas-asthi." Kupas, the common Bengali name for the cotton with the seed, used all over India and occasionally heard in Lancashire, is probably derived from the Sanscrit, according to J. Forbes Royle.

Herodotus, writing of the Hindoos, 400 B. C., says: "They possess a kind of plant which instead of fruit, produces wool of a finer and better quality than that of sheep, and of this the Indians make their clothes." Nearchus, Admiral of Alexander the Great, records the fact that the Indians wore linen garments, the substance whereof they were made growing upon trees; and "this is indeed flax, or rather something much whiter and finer than flax." He also gives the Indian name for cotton as tala. Evidently, the manufacture of cotton in India dates from a very antique period, for it had attained a high degree of excellence long before the time of which Herodotus wrote, and a large export trade in white and colored cotton fabrics had already been established. Strabo, noted for his accuracy, mentions on the authority of Nearchus, the flowered cottons of India, and celebrates the numerous beautiful dyes with which they were colored. They attained almost incredible perfection in their fabrics, and that with the rudest and simplest of implements. The cotton, being ginned by the churka, a wooden mill, made for that purpose (see Plate 2) and bowed, was spun by the women. A heavy one-thread wheel of teakwood, of the rudest make, was used for spinning the coarse yarn; while the finer threads were spun with the spindle, with or without the distaff. The yarn thus prepared was given to the weaver, whose loom consisted "merely of two bamboo rollers, one for the warp and the other for the web,

and a pair of geer. The shuttle performs the double office of shuttle and batten, and for this purpose is made like a large knitting needle, and of a length somewhat exceeding the breadth of the piece (this was not always so; sometimes, the shuttle was short and was thrown). This apparatus, the weaver carries to a tree, under which he digs a hole large enough to contain his legs and the lower part of the geer. He then stretches his warp by fastening his bamboo rollers at a due distance from each other on the turf by wooden pins. The balance of the geer he fastens to some convenient branch of the tree over his head; two loops underneath the geer, in which he inserts his great toes, serve instead of treadles; and his long shuttle, which also performs the office of batten, draws the weft through the warp, and afterwards strikes it up close to the web." With such simple apparatus as this did the Indian weaver manufacture "webs of woven wind," as Dacca muslins were called in the Oriental hyperbole. "Some calicuts," writes Tavernier, "are made so fine, you can hardly feel them in your hand." He further says of the turbans worn by the Mohammedan Indians,—"The rich have them of so fine cloth, that twenty-five or thirty ells of it put into a turban will not weigh four ounces." Another writer says,—"When this muslin is laid on the grass, and the dew has fallen upon it, it is no longer discernible."

India remained in advance of Europe in the industry far into the eighteenth century. Though largely imported into England, the Indian cotton goods were regarded with great disfavor by the home manufacturer, though they brought large profits to the merchants. Daniel DeFoe, in his "Weekly Review" in 1708, says, in regard to the preference exhibited by the people for Indian chintz, calico, etc.,—"It crept," he says, "into our houses, our closets, our best chambers! curtains, cushions, chairs, and at last beds themselves were nothing but calicoes and Indian stuffs, and in short, almost everything that used to be made of wool or silk, relating either to the dress of the women or the furniture of our houses, was supplied by the Indian trade. The several goods brought from India are made five parts in six under our price, and being imported and sold at an extravagant advantage, are yet capable of underselling the cheapest thing we can set about." We shall see later on how unfounded were his fears.

From India, cotton goods were early introduced into Persia, and a reference to them occurs in the book of Esther (Chap. 1, v. 6) in the description of the decorations of the palace of Shushan for festivities given by King Ahasuerus, B. C. 519, which mentions that there were white, green and blue hangings, the word translated green being in the Hebrew, Karpas, and should be rendered cotton-cloth, so that the hangings were of white and blue striped cotton. (We are indebted to the work of Mr. H. Lee for this explanation, and he is also authority for the assertion that cotton was known in Egypt as early as 550 B.C.). Alpino, the Paduan physician and botanist, (1553-1607) records that the Egyptians im-

ported cotton at that date, that gossypium herbaceous did not grow there, but that gossypium arboreum was cultivated in private gardens as an ornamental plant, and the down was not used for spinning. The Greeks were acquainted with muslins and calicoes brought from Egypt two hundred years before Christ. A little later, 63 B. C., P. Lentulus Spinther, the Roman ædile, introduced cotton in the Apollinarian games, and Cæsar the Dictator covered with awnings the whole Roman Forum and the Sacred Way from his own house to the Capitoline Hill.

In the seventh century, cotton was freely cultivated and manufactured in Arabia and Syria, but not until the tenth century was it grown for manufacturing in China. The Moors introduced it into Spain (712 A. D.) but when the Moorish domination of Spain was crushed in 1492, the manufactures fostered by them were discarded; yet the cotton plant is still found growing wild in that country. Under the influence of the Moors, cotton was cultivated in Greece, Italy, Sicily and Malta, but when they were expelled from Europe, it departed for a time also. The art first revived in Italy. In the fourteenth century, the fustians and dimities of Venice and Milan were much esteemed in Northern Europe. Next, it was established in Saxony and Suabia, and found its way into the Netherlands, and fustians were largely manufactured in Prussia and Germany. Two events made the fifteenth century a crucial epoch in the history of the cotton trade—the discovery of America by Columbus, and the discovery of the passage to India round the Cape of Good Hope by Vasca da Gama.

Sailing westward in quest of a nearer route to India, Christopher Columbus reaching one of the Bahamas thirty days after leaving Spain, the natives in canoes surrounded his ship, offering for barter cotton yarn and thread in skeins.

In Cuba, he saw the women clothed in cotton garments, and noticed the hamacus (hammocks) of strong cotton cord. Oviedo, the Spanish historian and chronicler of the Indies (1478-1557), gives the same account of Hayti, and at the discovery of Guadaloupe in the same year, cotton thread in skeins was found everywhere and looms with which to weave it; in all of these places, the idols were made of cotton. This manufacture had evidently been handed down from a far distant time.

The "new world" is after all as old as the rest of the globe and was apparently as early populated. In Mexico, and in Central America, are found indubitable proofs of the greatness and the culture of former dwellers in the land. Pyramids, vast as those of Egypt, huge reservoirs, aqueducts, and the ruins of temples and palaces record the fact that a powerful and wealthy nation, skilled in all the important arts of civilization, once existed. But these are their only records; we know nothing of their history.

In Peru, Pizarro and his soldiers in 1532 found evidences of the same antiquity. Humboldt describes the great road from Quito to Cuzco,

built by the ancient Peruvians, and macadamized with broken stone mixed with lime and asphalte as "Marvellous." Tombs, temples and palaces arise on every hand. They have lain in ruins for centuries, but are still traceable. They were the works of men who lived thousands of years ago, and amongst their manufactures was that of cotton. There are in the British Museum some mummy cloths woven of cotton, the "fibres of which under the microscope are very tortuous, and resemble those of Gossypium hirsutum." It would seem therefore that the cultivation and manufacture of cotton in the New World was very likely coeval with the similar use of it in India. The dress of the Incas or sovereigns of Peru was composed of cotton of many colors spun and woven by the "Virgins of the Sun." When Cortez conquered Mexico in 1519, Mexicans had no textile fabrics except those made from cotton, nor had they flax, or silk, or wool. Cortez, fired with enthusiasm at the beauty of the hangings and garments presented to him by the natives of Yucatan, sent home to his emperor, it is recorded, "counterpanes," "under-waistcoats," "carpets," and "handkerchiefs." Particularly are noted a variety of mantles, some of which were chequered and figured in various colors, the outer side of the garment bearing long nap, like a shaggy cloth. Obiardo Barbosa, of Lisbon, visited South Africa in 1516, and found the natives wearing cotton, and as early as 1590 cotton was imported into London from the Bight of Benim.

In England no cotton was woven at this period, the small quantity used for candlewicks, etc., being brought either from Italy or the Levant. In 1560, however, England imported a small quantity of cotton and seemed desirous of competing in its manufacture; in 1585, a fresh impetus was given to this ambition by the advent of Flemish refugees, who sought in England a refuge from the cruel religious persecutions to which they had been subjected in the Netherlands.

In a poem entitled "The Processe of the Libel of English Policie," published in 1430, mention is made of cotton. Hakluyt mentions "cotton-wool" as being brought "in tall ships of London" from Cyprus and other ports in the Levant. Cotton was imported from Antwerp, also, in 1560. In the "Treasures of Traffic," which was published in 1641, the author, Lewes Roberts, says of the Manchester manufacturers,—"They buy cotton wool in London that comes first from Cyprus and Smyrna, and at home work the same, and perfect it into fustians, vermilions, dimities, and such other stuffs, and then return it to London." In Fuller's "Worthies of England," mention is made of Humphrey Chetham, the celebrated founder of the Blue Coat Hospital and Library at Manchester, as being engaged in the manufacture of cottons, especially of fustians "then in almost general use throughout the nation." so that fustians must have been made in Manchester long before the publication of Lewes Roberts' book. Calico printing was begun in England in the latter part of the seventeenth century. In the "Daily Advertiser," of September 5, 1739, was published an

article which says: "The manufacture of cotton, mixed and plain, is arrived at so great perfection within these twenty years, that we not only make enough for our own consumption, but supply our colonies and many of the nations of Europe." Sir Edward Baines' "History of Cotton Manufacture" furnishes the following table of imports of cotton into England in the infancy of the cotton manufacture, and shows how trifling was the vaunted prosperity of the cotton trade, as compared with the operations of to-day.

QUANTITY OF COTTON WOOL IMPORTED INTO ENGLAND.

YEAR.	POUNDS.
1697	1,976,359
1701	1,985
1710	715
1720	1,972,805
1730	1,545,472
1741	1,645,031
1751	2,976,610
1764	3,870,392

As Great Britain was the latest among the nations to adopt the manufacture of cotton, in which she has long led the world, so the United States was the last to enter the list of the cotton-growing nations of which she has long been the foremost. (See Roper: History of Cotton Production in the United States, *Ibid.*)

In 1738, began the marvellous inventions which have had so large a share in contributing to the commercial prosperity of the manufactures of both England and America.

In that year, John Kay, a native of Bury in Lancashire, invented the fly shuttle and introduced it to the woollen trade; but it did not come into general use in the cotton trade until 1760, in which year Robert, son of John Kay, invented the "drop box." The next invention to be recorded was of stupendous importance, and practically revolutionized all former methods in the fabrication of textiles. In England, the gravest impediment in the manufacture of cotton had long been the impossibility of obtaining yarn in sufficient quantities to keep the looms of the weaver busy. The spinning at that time was all done by women in the homes, by means of a hand-wheel, fashioned after the old Indian wheel, which had been introduced into Europe early in the sixteenth century. Spinning by this one-thread wheel was a tediously slow process, and though wheels were turning from morning to night in thousands of cottages, they could not keep pace with the demand. The cotton was converted into yarn by two processes, roving and spinning. The spinner took the short, fleecy rolls, as

they came from the hand cards and applied them successively to the spindle. With one hand she caused the spindle to revolve; with the other, she drew out the cardings, which, receiving a slight twist from the spindle, were converted into thick threads, called rovings, and wound upon the spindles so as to form caps. In the next process, the roving was spun into yarn, the operation being similar, but the thread was drawn out finer and received much more twist. So slow an operation was necessarily an expensive one; and was a grave obstacle in the establishment of the new manufacture. The spinners' and the weavers' minds were full of it, and there were many fruitless experiments, no doubt, before the solution of the difficulty was obtained and a machine was invented by means of which twenty, fifty, a hundred, or even a thousand threads could be spun at one and the same time by a single pair of hands. This was prior to Sir Richard Arkwright's patent, and was the invention of one Lewis Paul, of Birmingham, whose roller machine for spinning was patented in 1738. Claims were later made by the sons of his partner, John Wyatt. (See sketches of Paul and Wyatt, Vol. II. of this work.) Sir Edward Baines, in his valuable work, the "History of Cotton Manufacture in Great Britain," gives the full text of the Letters Patent, and that document proves beyond a doubt that the mode of spinning by rollers was invented fully thirty years before Arkwright took out his patent for a similar machine. The "spinning engine," as it was called, was set up in 1741, in a large warehouse, near the well in Upper Priory, Birmingham. It was propelled by two or more asses, walking round an axis. Another manufactory was established at Northampton, which was moved by a water wheel; the machines consisting of several frames, bearing 250 spindles and bobbins. The ultimate failure of these enterprises was largely due to want of experience in the owners; but for which the quickening of the cotton industry would have been accelerated by thirty years.

In 1748, the process of carding, which hitherto had been effected by stock cards was facilitated by the invention of rotary cards, for which in that year Mr. Lewis Paul, the patentee of Wyatt's Spinning Machine, took out a patent. In 1758, he took out a patent for the spinning machine, an improved type of the model of 1738.

One of the very early improvements made in the carding machine was a feeder in 1772 by John Lees. Of the crank and comb, Hargreaves was the original inventor, though this contrivance was embodied in Arkwright's carding machine.

About the year 1764, a poor weaver named James Hargreaves, who was employed in a cotton mill in Lancashire, first made a machine in that county which spun eleven threads. It is said he discovered the principle of his machine by the accidental overturning of a spinning wheel. At first he kept the machine secret, and his family spun weft from it for his own weaving. The secret was, however, discovered and a mob broke

into his house and destroyed the jenny and most of the furniture, and he himself was so persecuted that he was obliged to fly the country. He retired to Birmingham in 1768, where he entered into partnership with Thomas James, and they built a small mill. In 1770, Hargreaves obtained a patent for the jenny, but before leaving Lancashire he had built a few of the jennies for sale and its importance being recognized by manufacturers and weavers alike, it was brought into general use. So confirmed, however, were the prejudices of the spinners, that "a mob arose and, scouring the country for several miles around Blackburn, demolished the jennies, the carding engines, the water frames and every machine turned by water or horses."

One Thomas Highs, a reedmaker of Leeds, in 1769 invented a water frame, which it was claimed later was the prototype and model of later machines, and it is claimed he also invented a spinning-wheel, which antedated that of Hargreaves.

In 1768, Richard Arkwright, having completed a model of the "spinning engine" and being devoid of means to carry out his invention to a practical issue, repaired to his native Preston, and applied to a friend for assistance. This friend, Mr. John Smalley, entered into partnership with him, and fearing that the riots which took place in Blackburn on the invention of the spinning jenny would be repeated, Mr. Arkwright, accompanied by Mr. Smalley, went to Nottingham, and there was introduced to Mr. Samuel Nud of that city, who was in partnership with Mr. Jedediah Strutt of Derby, that patentee of the stocking frame to whom, we must not forget, Samuel Slater, of Rhode Island, was apprenticed.

The roller-spinning frame was now patented (1769) and was greatly improved later by Arkwright, who like all the early inventors of machinery, encountered the animosity of his fellow-manufacturers in various ways, though he was the most successful of his class. He and his partners, Nud and Strutt, erected a mill at Nottingham, which was driven by horses; but this power proving too expensive, a much larger mill was built by them at Cromford in Derbyshire, the motive power being furnished by a water wheel, and from this circumstance the spinning machine was called a water frame.

Before these two important inventions of the spinning jenny and the water-frame, the chief obstructions and impediments of the cotton manufacture vanished. The machines not only spun more yarn, but they spun better yarn. The new water-frame produced a hard, firm thread, adapted for warp; therefore linen warp, which had been everywhere used, was abandoned, and goods were for the first time woven entirely of cotton. On the other hand, the jenny was peculiarly adapted for spinning weft, so that the two machines did not conflict, but were brought into use together, and finer and more delicate fabrics were introduced, especially calicoes imitated from the Indian article of that name. The spirit of invention

was now aroused into marked activity, and much experimentation evolved various improving devices in the new machines. But the opposition encountered by the machines, owing to the ignorance and prejudice of the workmen, caused the impetus imparted to the trade by the new machine to be followed by a lull, and the imports of cotton into Great Britain did not exceed 4,764,589 pounds a year up to 1775.

On the 16th of December, 1775, Mr. Arkwright was granted another patent for a series of machines, which comprised the carding, roving, and drawing machines, all used "in preparing silk, cotton, flax and wool for spinning." Yarns were now produced far superior in quality to any before made, as well as lower in price, and a mighty impetus was given to the cotton manufacture. Weavers could obtain an unlimited quantity of yarn at a reasonable price, and cotton fabrics could be sold lower than ever before; the price of the manufacture being still further lowered by the use of cotton warps in place of linen. The demand for them consequently increased, and numerous spinning mills were built to supply the requisite amount of yarn. Arkwright's fame filled the land and capitalists flocked to buy his machines. He and his partners spent upwards of £30,000 on their buildings in Derbyshire, and he also built a very large and costly mill in Manchester, and a business was formed which employed upwards of 5,000 persons, with a capital, on the whole, of not less than £200,000.

The factory system in England took its rise from this period. Up to this time, the manipulation of cotton had been effected almost entirely in the houses of the workmen; the hand or stock cards, the spinning-wheel and the loom requiring no more floor space than could be afforded in a cottage. A spinning jenny of small size also could be, and often was, used in the same way; but the water-frame, carding engine, and other machines now brought out by Arkwright in a finished state, required not only a certain amount of floor space, but their weight necessitated that they should be placed in strong buildings, and they required the strongest impelling force then known; namely, that of water.

The machinery called for a further division of labor than was requisite in the primitive state of the manufacture; it was found expedient to utilize the power obtained from each water-wheel by carrying on the numerous operations of an extensive manufacture in one building; these and other considerations led to the introduction of the factory system, and mills were erected at many points where water power was accessible.

Arkwright was making a large fortune, not only by his patents, but by the various manufacturing enterprises in which he had a share, when several persons, believing that he was not really the author of the inventions by which he was profiting, ventured to set up similar machines without leave or license from him. He therefore in 1781 instituted nine actions for infringement, one only of which came to trial, that against Colonel Mordaunt. This action was for the infringement of the second patent for

the carding, drawing, and roving machines, and the patent was set aside. He made an effort to regain this second patent with the result that his claims to priority of invention were disallowed and the patent was annulled in 1785, the patent for the spinning machines having expired in 1783, and the surprising amplification of the manufacture which almost immediately followed, proved that the nullification of this patent was of the utmost national advantage.

Arkwright undoubtedly possessed inventive talent of a very high order, but the splendid achievements in the line of invention attributed to him, even to the present day, belonged in great part to others less successful than he; in appropriating them as his own, he "acted dishonorably and left a stain upon his character which the acknowledged brilliance of his talents cannot efface." (See Sir Edward Baines' "History of the Cotton Manufacture.")

During the years 1774 to 1779, Samuel Crompton was busy inventing the spinning mule, which superseded the spinning jenny and to some extent the water-frame also. No patent was taken out by the author of this admirable machine, it became public property, and while many were enriched by it he remained a poor man, his only reward being $5,000, awarded him by act of Parliament in 1812.

The first self-acting mule was invented somewhere between 1780 and 1790 by Mr. William Strutt, of Derby, son of Mr. Jedediah Strutt, but for some reasons it did not come into successful operation. Mr. Kelley, in 1792, made a self-acting mule. Later on, several mechanics in England, Scotland, France and America, invented devices to render mules self-acting, none of which were absolutely successful. But in 1825, Mr. Roberts of the firm of Sharp, Roberts & Co., machinists, Manchester, invented a self-acting mule for which a patent was granted, a second one for an improved machine being granted in 1830. This last mule approached very near perfection and came rapidly into use.

Such was the efficiency of the mule that at first it seemed probable that the water-frame, like the jenny, would fall into disuse; but a little later on, when the power-loom came into being, it was particularly desirable to have twist for warps of the wiry smoothness which the water-frame produces, and the improvements which were effected in that machine enabled the manufacturers to sell the low counts of water-twist yarn cheaper than the mule-twist. The improved machine was called a throstle; and the improvement lay chiefly in the simplification of the gearing. Further improvements, which largely increased the velocity of the machine, were made by American machinists in later years. About the year 1817, the fly-frame came into being, and this was followed by the tube-frame; Mr. Henry Houldsworth was the patentee of the former in 1825, the tube frame being invented in America and patented in England by Mr. Dyer, of Manchester, in 1825.

We have followed the gradual evolution of spinning machinery to the first quarter of the nineteenth century, and must now retrace our steps in order that we may contemplate the further extension of its usefulness by the adoption of one of the most mighty impelling forces known to man,—Steam. Had not this discovery been made, the building of mills in Lancashire, the birthplace of the cotton industry, must have ceased when all the available water-power had been utilized.

The honor of first applying steam as a mechanical power has generally been ascribed to the Marquis of Worcester; but that ingenious and eccentric nobleman's recognition of the immense power of steam was anticipated nearly forty years before the publication of his work, the "Century of Inventions," in 1663, in which he describes his experiments and their results. As early as 1615, Solomon de Cans, engineer to Louis XIII, in a book published in that year propounded the raising of water by steam as a philosophical principle. In 1630, a patent was granted by Charles I, to David Ramsaye, a groom of the privy chamber, for nine articles of invention, of which two appear to indicate the original of the steam-engine; namely, "To raise water from low pits by fire," and "to raise water from low places, and mynes, and coal pits by a new way never yet in use." But it was not until July 25, 1698, that a patent was granted to Captain Savery, of Cornwall, for a steam-engine, which was considered so important that an act of Parliament was passed, "for the encouragement of a new invention by Thomas Savery, for raising water, and occasioning motion to all sorts of mill work, by the impellant force of fire." Before he obtained his patent, Savery had erected sundry steam-engines to pump water out of Cornish mines, and had published a description of his engine in a work entitled "The Miner's Friend," in 1696. This engine was extremely defective from the fact that it caused an immense waste of both steam and fuel, and was so limited in its capabilities that it could only be used in certain situations. Thomas Newcomen effected a considerable improvement in it, and he and Savery obtained a joint patent for the new engine in 1705. Mr. Brighton, in 1717, simplified the movements of the machine without altering its principles; and from that time until 1769, little change was made in it. And now came James Watt, a native of Greenock, who had qualified as a maker of philosophical instruments in London and Glasgow, and who settled in the latter city in 1757. He was appointed an instrument maker to the University and there became acquainted with Dr. Black, who about that time published his important discovery of latent heat. His study of this doctrine led Watt to make the prodigious waste of heat in the steam-engine the subject of his serious contemplation. In 1763, he was called in to repair a small working model of Newcomen's steam-engine. Its defects were apparent to him and he at once set about to repair them. for he perceived the prodigious capabilities of steam, if it could only be properly applied. After years of patient labor, experiments so costly that

his means were almost exhausted, he succeeded in developing the steam-engine into the most valuable instrument for the application of power that the world has ever known. It is worthy of note that his patent for "lessening the consumption of steam and fuel in fire engines," should have been taken out in the same year as that of Arkwright for spinning with rollers, namely, 1769. This first patent did not include all Watt's improvements in the steam-engine; in 1775, he entered into business with a Mr. Boulton, an enterprising man of wealth who had great mechanical talent, and having made further improvements in the steam-engine, Parliament in that year passed an act vesting in Mr. Watt "the sole use and property of certain steam-engines (or fire engines) of his invention, throughout His Majesty's dominions," for the term of twenty-five years. He took out three later patents in 1781, 1782, 1784, for further improvements.

The first steam-engine made for a cotton mill, by Boulton and Watt, was set up in the factory of Messrs. Robinson, at Papplewick, Nottinghamshire, in the year 1785. Messrs. Arkwright and Simpson had put up an atmospheric engine in their cotton mill at Shude Hill, Manchester, in 1783; but not until 1789 was the first steam-engine used in that town for cotton spinning built for Mr. Drinkwater by Boulton & Watt; Sir Richard Arkwright first adopted the new invention in a cotton mill in Nottingham, in 1790. In Glasgow, the first engine for cotton spinning was set up for Messrs. Scott and Stevenson, in 1792. The spinning machinery had created the cotton industry; the steam-engine fostered it and extended it far beyond the limits it could have attained had it been restricted to the motive power attainable before the birth of steam-power.

But the inventive genius of those who sought to advance the cotton manufacture was not exhausted by these splendid efforts, and we must next note the improvements brought about in the loom itself and in the methods by which its operations were conducted. In 1695, a loom moved by water power, was made by M. de Gennes, which is described in the Philosophical Transactions of the Royal Society for 1678, as "a new engine to make linen cloth without the help of an artificer," but it did not come into use. Prior to 1765, a swivel loom was invented by Vaucanson, and in 1765, a weaving factory was built by Mr. Gartside, probably fitted with those looms; but no real advance was made, as each loom required a man to work it. In 1765, the Rev. Dr. Edmund Cartwright, of Kent, invented a power loom and attempted to manufacture with it; but in this he was unsuccessful. He spent a large fortune, which he had inherited from his father, in his efforts to make practical use of his loom and certain carding machines which he had invented, and his circumstances became precarious. At this juncture, Parliament, in 1809, came to his assistance with a grant of £10,000 as a reward for his ingenuity.

About 1790, Messrs. Grimshaw, of Gorton, under a license from Cartwright, built a weaving room at Knott's Mills, Manchester, and at

great cost to themselves, endeavored to improve the power loom. Their effort was so far unsuccessful that on the burning of the factory, they abandoned the enterprise.

In 1794, a power loom was invented by Mr. Bell, of Glasgow, which was unsuccessful. Mr. Robert Miller, of Glasgow, in 1790, took out a patent for a machine of the same order, and Mr. Monteith, of Pollokshaws, Glasgow, fitted up a mill with 200 of these looms, but it was some years before the business proved successful.

The chief difficulty in the effective working of the power loom was at last solved by the patenting in 1803, of a dressing machine, by Thomas Johnson, who, working under the direction and encouragement of his employers, Messrs. Radcliffe and Ross, of Stockport, produced this essential accessory and made the use of the power loom possible. In that same year, Mr. H. Horrocks, of Stockport, took out a patent for a new power loom, upon which he obtained further patents for improvements in 1805 and 1813. Mr. Peter Marsland, of Stockport, obtained a patent in 1806, for a power loom with a double crank, which failed of adoption, although it produced very superior cloth. Horrocks' loom is the one which came into general use, being a neat, compact, simple machine, very rapid in motion. The power loom and the dressing machine came very slowly into favor. In 1813 there were but 2400 of the former and one hundred of the latter in use, yet this was sufficient to awaken the alarm of the hand-loom weavers, who broke the power looms set up at West Houghton, Middletown, and other places. But its great value in course of time was fully proven, and in 1829 there were 45,500 power looms in full activity in England, and 10,000 in Scotland, this being regarded as a conservative estimate.

We must note another series of inventions which have multiplied the efficiency of the ones already recorded a hundredfold. These are directed to the preparatory processes by which cotton is made ready for spinning, and to the final and finishing processes after it has left the loom. Snodgrass, of Glasgow, in 1800, invented the scutching machine, and in 1814 the lap machine was introduced by John Crighton, of Manchester, in almost the same form in which it exists today, and its inventor also effected vast improvements in the methods of opening and scutching. The invention and gradual evolution of the carding machine cover nearly the whole of the nineteenth century, the first important improvement being effected in 1823, and the principle of the revolving flat card was devised in 1834, but lay dormant for over thirty years, when it was taken in hand and developed in 1857, its usefulness being further extended in 1880 by the Messrs. Ashworth, and it became practically the carding machine of to-day. The combing machine was first exhibited by its inventor, Mr. Josué Heilmann, of Mulhouse, at the Paris Exposition of 1851. Mule and frame spinning have been much simplified by various devices and

improvements, the first change being made in the Crompton mule by Richard Roberts, who converted it into an automatic machine in 1835. The development in frame spinning has been far greater than that in mule spinning; improvement followed improvement until the Rabbeth spindle reached what seems to be the practical limit of speed.

In the loom much has been done in the past decade; the principal difficulty, loss of time in the changing of the shuttles, having been effectively removed by the invention of the Northrop loom which has two most important improvements, the first of which wholly prevents loss of time by stoppage for shuttle changing, and the second, causes the instantaneous stopping of the loom if a single warp thread breaks.

Having followed the great fundamental inventions of machinery for cotton manufacture step by step, we can only cursorily mention the fact that improvements and new applications of those fundamental principles have been made by inventors all over the world, but mainly in England and America, during the century and a half that has followed. In the manufacture of textiles from cotton, Great Britain now leads, Lancashire being the greatest cotton manufacturing centre in the world. There were in the United Kingdom, in 1905, over 53,000,000 cotton spindles in active operation. Cotton manufacturing under the factory system, made possible by the inventions of Wyatt, Kay, Hargreaves, Arkwright, Crompton, and Cartwright, had its inception in the county of Lancashire. The industry is concentrated within a radius of thirty miles around Manchester, the rest of the county being mainly agricultural and mining; coal and iron being two of the products which have rendered the locality so peculiarly suited for a manufacturing centre. At the beginning of the year 1906, there were operating in Lancashire 48,322,684 cotton spindles and 684,811 looms. Of this number, 2,430,367 spindles and 32,371 looms were put into new mills in the preceding year; later in 1906, ninety new mills were put into operation, organized, under construction, or projected, to contain 8,026,356 spindles, 5,937,356 of which consume American cotton, the remainder will spin Egyptian. One mill, The Mammoth, has 250,000 spindles. The extension of this gigantic industry goes on by leaps and bounds, and Lancashire has added 10,000,000 spindles to her productive capacity within a few years. During 1906, Great Britain increased her total exports of manufactured cotton, $36,600,000.

During the years 1909-1910, the too rapid increase of mills and the short cotton crops in Egypt and America during the former year somewhat diminished the prosperity of the cotton manufacturing industry of the Kingdom. For 1910 the number of spindles in active operation was 53,-397,000.

As we contemplate the splendid achievements of the early inventors of cotton machinery, and their effect upon the manufacturing industry in England, we can realize that those of her sons who left her shores to

venture in the New World, were not inactive in the new industry that opened such a promising market for their raw material in the way of cotton. Spinning and weaving were of course practised in the New World by the earliest colonists; but they were home industries, the women spinning the yarn from which they wove cloth for their households, at first of wool or flax, but later of the cotton which grew so abundantly to their hand in the warmer latitudes of their new country. About 1786 came others who had knowledge of the new carding, spinning and roving machines, but as an embargo was placed upon the exportation of machinery or of models or drawings of it, they necessarily had to depend upon their memories, which usually proved defective in some vital point, so that while copies of the English machines were built at various points by different persons, few of them were of any practical value. Some exceptions there were, such as the jenny, built after the model of Hargreaves, by Christopher Tully, in 1775, which was placed in a building at the corner of North and Market streets, Philadelphia, and operated by the "United Company of Philadelphia for Promoting American Manufactures." In 1786, Robert and Alexander Barr, of Scotland, came to East Bridgewater, and built machines for carding, roving and spinning, and the General Court granted them £200 bounty. Another model was made in 1787 by Thomas Somers, an Englishman, who received twenty pounds bounty; these machines were all made for Mr. Orr, of Bridgewater, and remained in his possession that all might examine them, but there is no record of their practical use. In 1788, a small mill was built at Beverly, Mass., in which a spinning jenny, made after a model furnished by Somers, was operated by horse-power. About the year 1788, Daniel Anthony, Andrew Dexter, and Lewis Peck, of Providence, entered into partnership for the purpose of engaging in the manufacture of cotton, and went to Bridgewater to examine the model brought by Orr from England; finding it imperfect, they laid their drawings aside for a time, and built a jenny after the one at Beverly, the model for which had been furnished by either Leonard or Somers. This jenny had twenty-eight spindles, and was finished in 1787, and was operated in the market-house chamber in Providence, and Joshua Lindly, of Providence, constructed a carding machine from the model at Beverly. They then proceeded to build a spinning-frame from the model at Bridgewater; it was operated by a crank turned by hand, and was very imperfect. Later came Joseph Alexander (1788), a weaver from Scotland, and a loom was built under his direction and set in motion in the market-house chamber; this was the first fly-shuttle ever used in Rhode Island. The spinning frame, (Mr. Orr's), after being tried for some time in Providence was carried to Pawtucket, and attached to a wheel propelled by water, but it was too imperfect to be used. Shortly after it was sold to Moses Brown, of Providence, as was also a stocking loom brought to East Greenwich by John Fullem, a native of Ireland. An attempt had been made to run this ma-

chinery, by William Almy and Smith Brown, the capital being furnished by Moses Brown, but it was unsuccessful.

At this juncture, in a moment auspicious for his own fortunes, and for the country to which he took his way, a young man named Slater left his natal place, Belper, in Derbyshire, England, and came to New York. It must be remembered that at that period an embargo was laid upon the exportation of English machinery, while a bounty was given for the exportation of manufactured cotton goods. Manufacturers in the United States were dependent, therefore, if they wished to use the new machines then lately invented in the mother country, upon the memories of those who came to her shores, for their reproduction. Samuel Slater brought much valuable knowledge, especially of the master machine, the water-frame of Arkwright. He had served a strenuous apprenticeship under Jedediah Strutt, the former partner of Arkwright, and therefore was thoroughly conversant with the machines in all their details, and he was himself possessed of much mechanical genius, and imbued with the patience, perseverance and industry necessary in such an enterprise. He obtained employment in New York City, but finding no scope for his ability, he wrote to Moses Brown of Providence, of whose experiments he had heard, and offered his services as manager of spinning. They were accepted, and he went to Providence and found the machines worthless. An agreement was made whereby he entered into partnership with Almy & Brown, and then set to work to make a series of machines after the Arkwright pattern, which he successfully accomplished after much labor, and so set in motion the first of the series of great factories which to-day constitute the cotton industry of Providence.

After 1790, power looms were introduced, and it seemed as though the only obstacle to an unlimited extension of the cotton industry would be the impossibility of procuring sufficient raw material, when, in 1793, the invention of the saw gin made it possible to clear the fibre of seed rapidly, and flooded the market with cotton, to the great relief of planters and manufacturers alike, and gave added impetus to the impulse of the new and rapid machinery, not only in Rhode Island, but in the States of New York, New Jersey, New Hampshire, Connecticut, Maine, Vermont and even to some slight extent in the South. The first cotton mill in New Jersey was built in 1794 at Paterson; New Ipswich, N. H., 1804; Union Village, N. Y., 1804; Pomfret, Conn., 1806; Brunswick, Me., 1807; North Bennington, Vt., 1811; a second mill at Fall River in 1812; in 1815, the power loom in connection with power spinning was introduced by Francis C. Lowell, at Waltham, Mass., that being the first cotton factory to carry on in one establishment all the processes involved in the manufacture of the finished product from the raw material. The progress of the business of cotton manufacturing was thereafter continuous in the Northern States; in the South there has been more fluctuation, mills were built in Wilmington, Del.,

in 1795; James Island, S. C., 1797; in 1809, there were six small horse-power mills; in Petersburg, Va., there was one; and in Nashville, Tenn., one; the Bolton factory was built at Upton Creek, Ga., in 1811; a mill near Lincolnton, N. C., 1815; Covington, Ky., 1828; Flint River, Ala., 1832; New Orleans, La., 1838; Natchez, Miss., 1844; Cave Hill, Ark., and at Huntsville, Texas, in 1860. Slave labor, however, was not adapted to the factory, and the Civil War completely stultified the industry; in the period of rehabilitation which followed, it dawned upon the intelligence of the planters that the manufacturing, as well as the growing of cotton, would ensure the prosperity of the Cotton Belt and the contiguous States, and the spindle and loom have found an abiding place beside the cotton gin in the cotton plantations of the South. At first, the mills were gradually refitted with the latest improved machinery. A great proportion of the mills built in the past decade are quite equal to those at the North; in fact, many improvements are there found which do not exist in the North. The first factory operated solely by electricity, without shafting or belts, was located at the South. The growth of the industry in the Southern States was fairly continuous during the last ten years of the nineteenth century. Both North Carolina and South Carolina, spin more than half the cotton grown within their limits, and after a phenomenal growth during more than twenty years, the enlargement of old mills and the building of new mills is still going on. There were twenty-eight new mills built in the Southern States in 1910 in which 214,028 new spindles, and 3,752 looms were set in operation.

Notwithstanding the amazing progress of the cotton industry in the Southern States, the largest and densest concentration of cotton manufacturing in the United States is in Southern New England, as it ever has been since the days when Samuel Slater set in motion the first water-frame in Pawtucket, R. I., in 1791.

In the American State papers (Finance, Vol. III) a list is given of the mills existent within thirty miles of the town of Providence, R. I., in November, 1809. They are enumerated in the order of their establishment; twenty-seven mills were in operation with 20,046 spindles "now in operation," and having besides 14,494 unemployed spindles; there were also fourteen other mills all established in 1809, and evidently not yet in operation, having 23,000 spindles; the total did not greatly exceed the capacity of one Fall River mill.

The total number of cotton spindles in operation in the United States during the year 1910 were 24,192,359 ring spindles and 4,996,586 mule spindles, making a total of 29,188,945, which includes all spindles using cotton, as well as those in cotton mills only.

The exports of manufactures of cotton from the United States in 1910 amounted to the value of $33,398,672. The home consumption is very large; as an exporter of manufactured cottons, the United States ranks third.

The imports of goods in the same year amounted to the value of $66,473,-143.

In the manufacture of cottons, Germany ranks third, its production being excelled only by the United Kingdom and the United States, and next to Great Britain, it is the greatest exporter of cotton goods in the world. Its progress in these lines has been very rapid; in 1887 the total number of spindles in the empire was 5,054,795, which consumed 1,006,983 bales of cotton, and in 1910 the number of spindles had increased to 10,200,000, with a consumption of 1,660,000 bales of cotton. The number of looms in operation in 1910 was estimated as 231,199; the average spinning mill has 26,500 spindles, and the average weaving mill 364 looms.

Although cotton manufacturing is an old industry in Germany, it was not until 1879 that the modern German cotton industry commenced; and not until 1889 did the export business attain large proportions; since that time it has steadily increased, until Germany occupies the second position as an exporter of cotton goods.

The goods exported are chiefly textile specialties, such as knitting, embroidery, braiding, hosiery, gloves, etched lace, edgings, braids, etc. The knit-goods industry is one of the most important lines of the export trade and its steady growth accounts for the increase of her shipments of cotton manufactures to the United States within a few years, the export trade of the Empire in this line having doubled. The goods manufactured are largely of a cheap grade, in the production of which Germany uses a vast amount of cheap cotton. Next to Japan, she is the largest importer of Indian cotton; she also imports large quantities of cotton waste and of lint. In 1907, her imports of cotton amounted to the value of $127,-765,064. In 1907, Germany also imported over $29,000,000 worth of cotton manufactures, of which the principal item was fine yarns for use in the making of laces and embroideries; the bulk of the yarn imported (in 1907, it was 71,464,700 pounds out of 88,381,282) comes from Great Britain, with small quantities from Switzerland, France and India.

The manufacture of cotton waste into a great variety of finished products is quite an industry in Germany. Not only do the mills manufacture the waste from the German cotton mills, but they also import cotton waste from all parts of the world. In many cases the goods manufactured from this waste goes back in the shape of coarse towels, scrubbing cloths, dish rags, blankets, etc. In 1909 the value of cotton manufactures imported into Germany amounted to the sum of $64,349,488, while her exports of the same amounted to $95,524,870.

The growth of the cotton manufacturing industry in Italy has been very rapid during the past quarter of a century. There are in Lombardy about five hundred mills, that being about sixty per cent of the mills in Italy. The number of looms for the entire country is (exclusive of hand-looms) about 15,000 with 5,000,000 spindles, employing 300,000 people, the

weaving machinery being nearly all English. The total amount of the raw cotton imported into Italy is computed at 700,000 bales, 100,000 of which are from India; 500,000 from the United States; and 30,000 from Egypt. This amount is on the increase, as are the exportations of manufactured goods. Turkey, Roumania, Bulgaria, Egypt, South America, India and the Philippines are the principal foreign markets for the Italian export trade. Milan is now one of the great cotton textile markets of the world. During 1906 she sent to the United States cotton fabrics to the value of $45,000, and cotton waste worth nearly $120,000; to the Philippine Islands, $100,000 worth of textiles. The centre of the cotton textile trade is a few miles north of Milan at Busto and Gallarate, where there are about 150,000 looms (this being exclusive of hand-looms); there are 5,000,000 spindles in operation, with 300,000 operatives.

Italian hand-made laces are manufactured at Cantu, a place which lies a few miles north of Milan. Seven thousand persons are employed in this industry, "point Venice" being so popular both at home and abroad that the supply is inadequate for the demand. The real Venetian lace is if course made of pure linen yarn. The total value of manufactured cotton exports for the first nine months of 1906 was $15,750,000.

In Italy cotton was first manufactured in the fourteenth century. Daru, in his "History of the Republic of Venice," mentions it briefly, as do several other writers; but it seems to have been of small importance, and it is doubtful if the cotton goods made were not mingled with wool; those made entirely of cotton being brought to Italy and France from Syria and Asia Minor. The value of the cotton goods exported from Italy in 1910 was $25,646,333; and of those imported the value was $7,250,834.

The cotton-manufacturing industry in France is very extensive, nor is it confined to one locality, being found in thirty-three of the Departments. Before the loss of Alsace, 6,500,000 spindles were in motion. In 1895 the number was decreased to 4,600,000, but it has increased since then, and in 1901 Mr. Gaston Beaumont gives the number of spindles in motion as 5,000,000. The principal centres of production are the Nord, Normandy, the Eure, the Loire, and the Vosges. Since the annexation of the Upper Rhine, Normandy has become the chief seat of the industry, and produces more than one-third of the cotton manufactures of France, Rouen being the great industrial centre from which port most of the exportations to foreign countries and to the French colonies in Asia and Africa are made.

The development of the manufacture of cotton in France dates from the seventeenth century, when the raw material was introduced into that country for the first time in sufficient quantities to give rise to an industry. It is, however, mentioned in the archives at a much earlier date, and according to those of the Seine Inférieure and of the customs at Dieppe, it was of cotton that candlewicks, gloves, and caps were made, in Dieppe in 1302, on which there was a tariff of ten per cent. In 1541

and '42, there is an entry of fifteen and a half bales of cotton coming from Portugal, and of a dozen bales coming by way of England. At the close of the seventeenth century, the industry assumed a certain importance, mainly because of the new machinery invented about that time in Great Britain. In 1900 there were 5,500,000 spindles in active operation in France, and since then the industry has continued to grow, the number of active spindles in 1910 being 7,100,000, with a consumption of 951,000 bales of cotton.

France now ranks fourth among the European countries in the manufacture of cotton goods, and takes third rank as an exporter. In 1910 the exports of cotton goods from France were valued at $64,619,295 and the imports at $13,624,804.

Cotton manufacturing in Switzerland has been almost stationary for the past ten years. The coal and cotton is all imported and most of the textile machinery is made in England, while all of the lace machines are made at home. Much of the help in the mills is Italian and German. The mills are scattered, there being no great manufacturing centres as in other countries. The factories average 22,000 spindles apiece, or 300 looms. Hand-looms are a thing of the past, though lace is still to some extent a cottage industry. In textiles, the Swiss stand in the foremost rank for the production of fine goods. There are four yarn mills, having over 50,000 spindles. The President of the Swiss Cotton Manufacturer's Association gives the following figures for 1908: Spindles, 1,499,170; twister spindles, 117,782; with 2,342 operatives; and 22,709 looms, with 13,854 operatives. Forty per cent of the cotton used is Egyptian, and the remainder American, with a small percentage of Indian. The cotton imported into Switzerland in 1906 was:

American	30,111,268	pounds
Egyptian	19,766,133	"
Indian	2,271,222	"
Other	22,502	"

The total amount of textiles imported from Switzerland in 1906 amounted to the value of $41,000,115.

Cotton manufacturing is the leading industry of Austria, and is steadily becoming more important. The imports of raw cotton into Austria-Hungary in 1907 amounted to about $50,000,000, of which sixty-seven per cent was supplied by the United States. On January 1, 1907, there were 3,512,122 spindles in operation, to which about 600,000 were added during the year, making the total over 4,000,000 spindles, mostly mule spindles. In 1910 there were in Austria-Hungary 4,643,000 spindles in active operation.

The mills are mostly private concerns and are small. There are only twenty-two mills which operate over 50,000 spindles each, though the newer mills are much larger. Bohemia now contains about sixty per cent of the mills in the country. The centre of the Bohemian cotton industry, which practically means the centre of the cotton industry of Austria, is Reichenberg, and the towns adjacent to this place are rapidly becoming mill centres. The largest weaving mill has 2,397 looms; it is situated at Grunwald, in Bohemia. About one-third of the 650,000 bales of cotton imported into Austria comes from India, and it is mixed with American cotton. In Hungary, the business of manufacturing cotton is as yet in its infancy, and the government is offering many inducements to hasten its growth. Rozsahegy is the main cotton manufacturing centre and owns half the cotton spindles. The largest company is established in that town, the "Ungarisch Textilindustrie Aktiengesellschaft," which was founded in 1894. It has two spinning mills with 50,000 and 54,000 spindles each, a total of 104,000 spinning spindles; 7,000 twister spindles; 1,250 ordinary looms; and 900 Northrup looms. The next largest mill is at Budapest, and has 13,732 spindles and 340 looms. The present consumption of cotton is about 50,000 bales a year. Coarse goods are chiefly produced; the finer goods being sent to Bohemia to be bleached. Most of the mill machinery is English. The hand-loom is still in use and the weavers use 15,000,000 pounds of bundle yarn yearly, part of which is supplied by Hungarian mills and part imported. The skilled help in the Hungarian mills is mostly Austrian. In 1907 there were in operation in Hungary 200,000 cotton spindles. The exports of cotton manufactures of Austria-Hungary for 1910 amounted to $13,257,962, and the imports to $12,449,783.

Of other European countries, Belgium had in 1910 1,322,000 cotton spindles, and in 1909 exported cotton manufactures to the amount of $54,004,530; the importations of those goods for the same year amounting to $49,209,711. Spain has 1,853,000 active spindles; Portugal, 476,000; the Netherlands, 426,000; Sweden, 377,000; Greece, 9,000; Denmark, 83,000 and Norway about 74,000.

The leading cotton manufacturing districts of Russia are Moscow, with about 5,000,000 spindles; the Baltic Provinces, with about 1,800,000; and Poland, with about 1,250,000. During the past twenty years a notable growth in this industry has been achieved, the number of spindles having increased 120 per cent during that period. In 1900 the cotton spindles in active operation numbered about 7,500,000, and in 1910 had increased to 8,250,000. In 1909 cotton manufactures were exported from Russia to the amount of $10,689,328, while the importations amounted to $14,174,430.

Concerning the condition of the cotton trade in India in the first decade of the twentieth century, we cull much valuable information from the official report of Mr. W. A. Graham Clark, special agent of the Depart-

ment of Commerce and Labor. India, besides being a great cotton-producing country, is also a great cotton manufacturing country, and a large exporter mostly of yarn, much of which is later re-imported in the shape of cloth. The amount of cotton yarns spun in British India and the native states in 1906 was:

Nos. 1 to 10	166,066,232	pounds
" 11 " 20	359,363,974	"
" 21 " 30	105,779,111	"
" 31 " 40	15,607,009	"
" above 40	1,139,477	"

And in the same year she used 726,695,323 pounds of imported yarn.

The first spinning mill in India was established in 1817 on the banks of the Hooghly, near Calcutta, but it passed out of existence after a few years. The first cotton factory in India dates from 1854, when a Parsee merchant, named Cowasji Davur, built a small mill at Tardes, near Bombay. All the mills are patterned after the English type, and are filled with British machinery. The principal mill centres are Bombay, Ahmedabad, Calcutta, and Cawnpore, but the industry is spreading out and many mills have been built also in the native states. There are 217 mills in India, with 25,279,595 spindles and 52,668 looms, the largest mill being the Jacob Sassoon mill at Pard, near Bombay, with 92,840 spindles and 1,810 looms. The next largest number of spindles is 86,040 in the Bengal mill at Calcutta, while the largest number of looms in a single mill is 2,015 in the Century mill at Bombay. We must not forget, while mentioning the manufacturing resources, the 2,700,000 hand weavers, who consumed in 1906, 264,292,492 pounds of cotton yarn, to which must be added the hand-spun yarn which never finds its way into either the market or the mill; this averages about 325,000 bales, or 13,000,000 pounds, which gives nearly 400,000,000 pounds of yarn used by hand-loom weavers. A leading Indian authority estimates that the production of native hand looms amounts to 1,650,000,000 yards annually.

In 1906, India exported yarn to the amount of $46,738,000. The export of Indian piece goods is very much smaller than that of the yarn, but it is increasing. On coarse insized goods, the hand looms of India have practically a monopoly. In fine goods, they do not begin to compete with England, and the present competition is confined to medium heavy goods, such as T cloths, long cloths, sheetings, and the coarser grade of dhooties. India's best cloth market is in East Africa, next comes the Straits Settlements, then China, Ceylon, Turkey, and the Philippines. The cloth exported to the last-named country consists mostly of "Madras goods." In 1906, India shipped more cloth to the Philippines than did the United States.

The manufacture of cotton is one of the largest and most promising industries in Japan. The mills are well built and stocked, mainly with English machinery, and the English methods of preparing the cotton are followed. The operatives are mainly women and girls. The first cotton mill in Japan was organized in 1868 by Prince Shimadzu, at Kagorhima, in the province of Satsuma. This mill contained 6,000 spindles, all the machinery being imported from England by the prince. In 1887, there were twenty-one mills with 74,120 spindles; and in 1905, fifty cotton mills were in operation with 38,494 looms and 8,645,863 spindles, to which were added during the trade boom of 1906-7, 467,100 additional spindles. The Kanegafuchi Spinning Company is the largest in Japan and operates 218,-080 spindles and one hundred looms. No statistics are available as to the number of spindles and looms in Japan. There are a good many hand-loom factories, containing looms up to one hundred. These are employed in the weaving of fine muslins. The exports are on the increase to an appreciable extent; in 1905, Japan exported 267,114 bales of yarn, much of which goes to China. The exports of cloth are rapidly increasing, and Japanese goods are familiar in the Orient; while there is a slight decrease in the exportations of yarn, owing to the increased demands of the home industry.

China, in 1910, had seventeen mills, 2,200 looms and 463,948 spindles, all occupied in manufacturing goods for home consumption.

Latin America contains 307 cotton mills which are situated as follows:

Countries.	Mills.	Spindles.	Looms.
Brazil	137	1,000,000	35,000
Mexico	139	726,278	25,327
Peru	7	52,250	1,750
Colombia	5	20,000	300
Venezuela	2	11,000	250
Argentina	6	9,000	1,200
Guatemala	1	6,000	150
Chile	3	5,000	400
Ecuador	4	5,000	200
Uruguay	3		300
Total	307	1,834,528	64,877

There are no cotton mills in Cuba, Hayti, Dominican Republic, Salvador, Honduras, Nicaragua, Costa Rica, Panama, Paraguay or Bolivia. The capital invested in the industry is probably about $140,000,000.

The mills are mainly one-story only. There are some few Northrup looms made under the English patent, but most of the machinery is English, and the mills follow the English customs in most respects.

Brazil's methods in cotton manufacture are crude and costly. The amount of middle grade goods sold is small; the fine fabrics and better grades are imported because the wealthy classes will have them at any price; the cheaper and coarser grades are made at home. Most of the mills are in Rio de Janeiro and Sao Paulo. The cost of transporting the raw cotton to the mills is excessive, as it is carted, the vehicles being small and the cotton poorly baled and bulky. Labor is generally inefficient and power costly, coal being imported for all purposes. Yet the cotton milling business is successful, owing to the excessive import duties, which protect the mill owner at the expense of the consumer. The cotton goods imports of Brazil have been $15,000,000 to $16,000,000 for some years back, and in 1906 the United States' share in this trade was $590,007.

Brazil is the most important cotton manufacturing country in Latin America, and its mills turn out over 40,000,000 dollars worth of cotton goods. These are mainly gray goods and coarse, colored cottons. though there are seven print mills with thirty printing machines. Several of the larger mills make white shirting, muslins, lawns, etc., of fine quality. About half the mills are run by steam power; about a fourth are run by water power, and the remainder, which includes most of the larger mills, are run by electricity. The Mexican output is mainly coarse goods of narrow width, but about half a dozen mills that now make goods of medium fine grade, including white shirtings, muslins, organdies, fine prints, napped goods, handkerchiefs, napkins and towels, which compare favorably with those imported.

Peru makes no prints, but, in addition to gray cloth, makes some bleached goods. Columbia, Venezuela and Argentina make gray sheeting, to which the latter country adds drills, duck and a small amount of colored goods. Uruguay makes duck, coarse sheeting, khaki, denim, plaid flannelettes, bath towels, and a few fancy woven goods. In Chile are manufactured both cotton and linen goods, ginghams, stripes, colored flannels, etc.

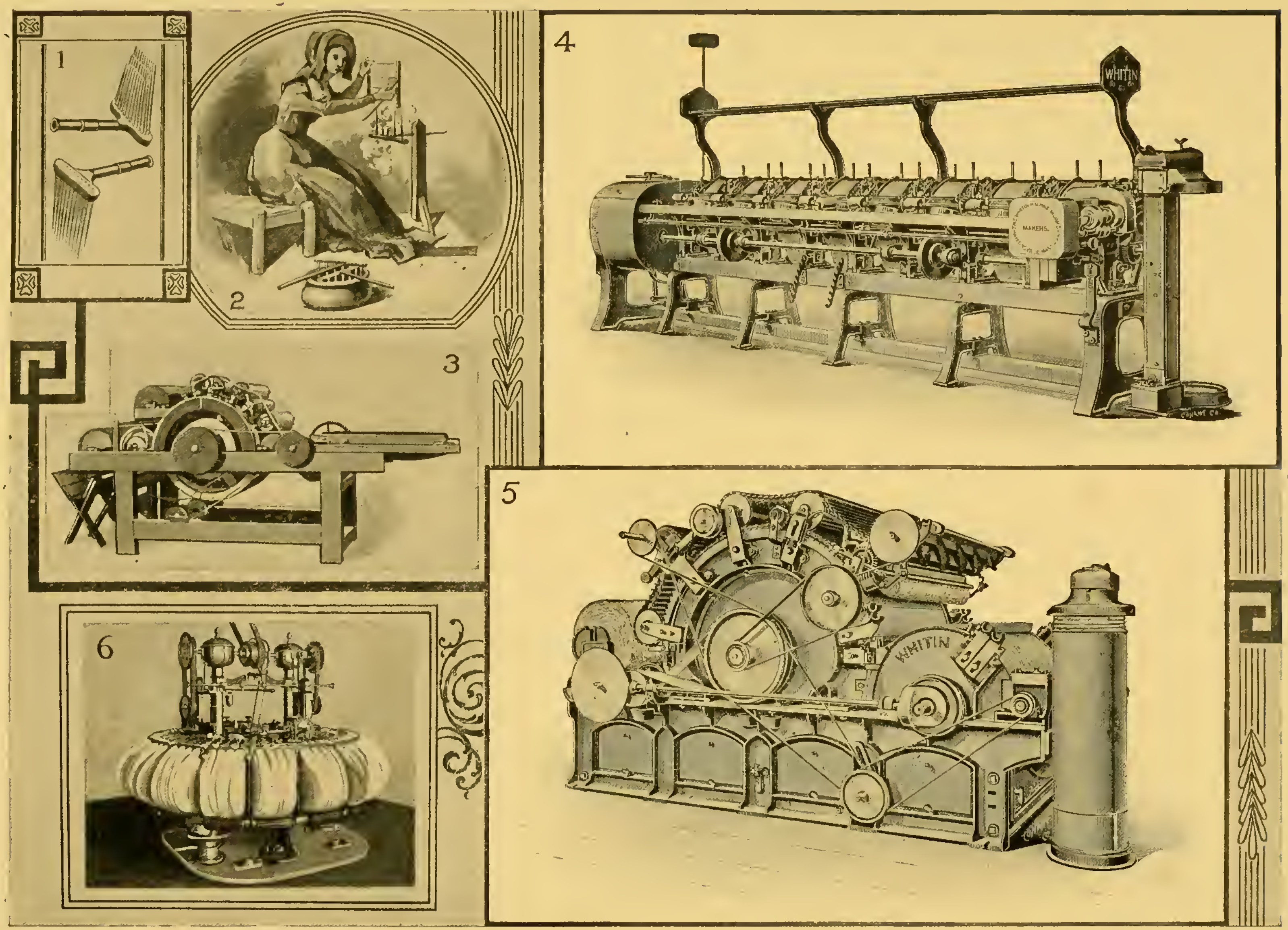
There is one mill in Central America with 6,000 spindles and 150 looms, making gray and colored goods.

There is but one cotton mill in the Philippines, which is situated at Manila. It is owned by an English importing house, uses English machinery, and is operated by Englishmen. The cotton used is chiefly American, which is mixed with one-fourth native. The mill makes its soft waste into candle wicks. The machinery consists of an opener and picker and one lapper; there are thirty-two cards, draw frames and fly frames, 10,000 spindles and 220 loooms, a few of which are dobby looms. The product is mostly coarse white shirtings with some convict-stripe cloth, and a few looms on chambray. Considerable hand-loom weaving is done in the country districts of the Philippines, and some really fine work is done. The annual imports of yarn are valued at from

$750,000 to $1,000,000, in addition to that made at the mill in Manila and by hand-spinning. Much of the native weaving is done with fibres other than cotton. The quantity of yarn and thread imported into the Philippines is steadily increasing. In 1903, it amounted to $641,164, and in 1906 had risen to $1,092,563. Yarn and thread are classed together, so it is impossible to particularize as to the quantity of each, but yarn undoubtedly preponderates. Over half of this comes from Great Britain, with Japan next; then Belgium, Switzerland, Italy, Germany, Spain, India and China, with smaller quantities from other countries. The greater portion of the yarn is shipped in 400-pound bales, containing forty bundles of ten pounds each. The finer and fancy yarns are shipped in bales and boxes of various sizes.

The possibilities of the trade in cotton fabrics in the Philippines are immense, the imports in 1906 amounting in value to $2,146,964. These consisted of closely-woven cloths, loosely-woven cloths, wearing apparel, carpets, yarn and thread, quilting and piques, velveteens and corduroys, tulles and laces, knit fabrics, etc.

PLATE IV—Combing and Carding



1. Primitive Combs.
2. Early Methods.
3. First Carding Machine.
4. Whitin Machine Company's High-speed Comber.
5. Whitin's Revolving Flat Card.
6. Noble Combing Machine.

JAMES H LAMB Co

COMBING AND CARDING

The hand-combing and carding of wool and cotton must of necessity have been one of the primal domestic arts, since without it there could have been no weaving of cloth. The operation is, in fact, pictured upon those earliest records of the industry and ingenuity of man—the Egyptian tablets. But though various minor improvements and modifications were made from time to time in the operation of combing, it was not until the eighteenth century that any attempt was made to invent machinery for this purpose.

The hand-comber, under the old system, employed two combs (see Plate 4); one of these a "pad" comb being affixed to a post, at a height convenient for the comber, by means of an iron rod fastened into the post. This raw wool having been submitted to the treatment necessary to prepare it for the operation, was "lashed" into each comb placed upon the pad. The combs, being charged with wool, were placed in the "comb-pot" to be heated, the comber meanwhile preparing handfuls of wool for his next charge. The workman then placed one comb upon the pad and with the other in hand began the combing operation by passing the teeth of one comb through the wool upon the other until the fibres of each became perfectly free of short wool or noils, the latter being left embedded in the comb heads.

The teeth of these combs, as may be seen (Plate 4), were pointed and tapering, arranged in three rows, the outermost row of the teeth being longer than those in the middle row which again were longer than those in the inner row. The stumps of these teeth which were of steel, were fastened about one-third of an inch apart, in a wooden stock covered with horn, and having a short handle. The operation was usually begun with a comb bearing only two rows of teeth, and to comb gradually from the tip of the wool up as a woman combs her hair, and was finished with the closer and finer comb. The short, flocky wool left in the comb after the comber had detached the combed and cleaned "tops," was, under the name of noils or noyles, set aside for the blanket or coarse cloth trade.

The very earliest English patent relating to wool-combing was that accorded to Isaac Mills, of Bellerton, in Somersetshire, in the year 1723, for "an instrument for heating combs for combing and pressing wool." Though the invention of Isaac Mills bore no reference to combing machinery, it throws light upon the methods of wool-combing as they existed at that date. Having, as he represented in his application, "been bred up in and followed

the trade of wool-combing and pressing for twenty-five years," he goes on to explain that "the usual way of method for kembing of wooll was by a fire made in a dry pot, the fire being open to the kembs, which did often neal the kembs and burn the wooll." It was further stated that for the pressing, the planks or iron plates were heated by a fire open to them, which often burned the planks and heated the iron plates so unequally that it frequently "burned the goods, to the great loss of the tradesman and discredit of the woolen manufacturer." His invention, calculated to remedy these defects, he describes as follows: "Two instruments of iron, to be used in the said trade of wool kembing and pressing, which are cast in such a form and contrived in such a manner, that a fire being made in the body of the instrument of iron for kembing, the kembs receive the heat from the same in such an equal proportion as neither to neal the kembs nor burn the wooll; and that for the pressing, the planks or plates being placed in the body of the other iron instrument, and a fire being made to encompass or surround the same, will heat the planks or plates in so true a degree as wholly to prevent the burning of the goods, and the great loss frequently sustained by the traders in the woolen manufacture thereby."

It was, however, left for that marvellous inventor, Dr. Edmund Cartwright, to make the first practical attempt to solve the great problem of wool-combing by machinery, and though many inventive minds bent their energies to the task of its ultimate and practical elucidation, to him belongs the merit of creating the germ of all subsequent machines for the combing of wool; for the leading principle of Cartwright's machine finds representation even in those of inventors who followed their own special lines and who were ignorant of his wool-combing achievements. (See Plate 4.) The wool-combing machine of Dr. Cartwright was even more original in its conception than that of his power loom, for in the latter case there was already in use a machine for weaving, cumbrous in its operation and slow in its motion, it is true, but which had performed its task with more or less perfection for thousands of years. In this case, it was different; a machine for the purpose of combing wool was undreamed of as yet; there was no intermediary operation between the simple process of hand-combing and the complex machinery now to be applied to the same purpose. We can present to our readers no more interesting description of the evolution of this machine than that afforded by the inventor himself in an article contributed to a scientific periodical of his day, a part of which is here quoted:

"This machine is, I believe, the first of the kind; at least, all former attempts (if there have been any) must have proved abortive; no wool was ever known to have been combed any other way than by the close and expensive process of hand labor. I obtained my first patent for this important invention on the 27th of April, 1790. In consequence of some additional improvements, I obtained a second patent on the 11th of De-

cember in the same year. But it was not until nearly two years afterward that my machine was brought to its present state of simplicity and perfection, when I took out a third patent, dated May 15, 1792. The wool, for particularly nice work, goes through three operations; otherwise, two are sufficient. The first operation opens the wool, and makes it connect together in a rough sliver, but does not clear it. The clearing is performed by the second, and, if necessary, a third operation. A set of machinery, consisting of three machines, will require the attendance of an overlooker and ten children, and will comb a pack, or 240 pounds in twelve hours. Machine-combed wool is bettter, especially for machine spinning, by at least twelve per cent, being all equally mixed, and the slivers uniform and of any required length. On the first introduction of this machinery, it was found, when not carefully attended, to produce a greater proportion of noil and pinion than good hand-combing, but in its present improved state it makes much less than any hand-combing whatever. The advantages of machine-combing arise not merely from the saving of expense; yarn spun from it has a decided superiority, especially for curious purposes, such as superfine hosiery, etc. At Messrs. Davison & Hawksley's mill in the neighborhood of Nottingham, where this machinery is made use of, yarn is spun of quality which it was thought no mill spinning could ever have arrived at. In justice, however, to the spirit and ingenuity of those gentlemen, it must be added, that their spinning machinery is supposed to be upon a very superior construction. Besides the above mill, my invention is already introduced into many others, and in all probability, as trade revives on the restoration of peace, will be universally adopted." (See Plate 4.)

The machine received the sobriquet "Big Ben" (after a celebrated prize fighter of that day), because the action of the crank lasher resembled the motions of a pugilist's arm. Like all other primal machines, the wool-comber met with opposition from some, was imitated by others, with little benefit to its inventor, and greatly to the detriment of its successful introduction into practical manufacturing; consequently, though embodying the principles of all future machines of the same character, Dr. Cartwright's machine did not fulfil the expectations of its inventor and others, nor for many years afterward was there a machine upon the market which was capable of clearing the wool as successfully as it could be done by the human hand. In 1793, a certain William Soplis obtained a patent for a series of combs and combers, an ingenious invention which met with little encouragement. The combs in this machine had curved teeth, and were affixed to arms and combers which when in action turned toward the combs.

In 1793 also made his initial appearance an inventor who later became prominent in this field, Mr. John Hawksley, who, with Henry Wright, applied for a patent in regard to machinery "for combing and preparing

fibrous materials for 'spinning.'" This machine consisted of an upright shaft revolving forty times a minute; a comb wheel with three rows of teeth on each arm; a combing cylinder with three rows of teeth, the wool being drawn from the cylinder by means of wheels and conducted by rollers into a can or basket; a feeding frame consisting of a fly with brushes and rollers, "to lay the wool close to the teeth of the cylinder," a pair of blast bellows for the purpose of conveying hot air to the wool, and to lay it; a circular brush which took the noils off the teeth; close to the brush was a second row of teeth to take the noils from the brush as it revolved.

Forming a portion of Hawksley and Wright's 1793 patent was a second combing machine which consisted of a "straight range of combs in three compartments, and connected by a hook or catch at the top, moving in a slide or groove, and made to remove or take off after they had passed 'the long cogged wheels, when they would have got quit of the wool.' A rack which had a very slow, sliding motion was moved by a pinion, two cogged wheels drew the wool from the comb teeth, against which were placed two conducting rollers. The motion of the straight range of combs being slowly progressive, it followed that when these had advanced the length of one compartment, that part was taken away and discharged of its noils, and then passed to the other end of the machine on an inclined plane or otherwise, and fixed in the vacancy, and so on alternately, by which means a perpetual sliver of wool was produced."

In 1795, a method of "opening the staple and bringing it into a proper state for lashing upon a comb" was patented by John Passman, and in the same year one Anthony Amatt received Letters Patent for a machine which successfully carried out the idea of working the hand comb by mechanical means. According to its inventor, this machine was upon "entire new principles for combing wool and heckling flax and hemp," and might be worked "by water, steam or horse mills, or by any other moving power." The patent covered three distinct machines for filling, combing and drawing off. Later inventors paid much attention to this idea of Amatt, and improvements upon it were patented by James Noble in 1834; Donisthorpe & Rawson in 1835 and 1840; by Collier and several others; but although these successive efforts brought the principle of the mechanism to the highest degree of perfection," the machines required so many hands to attend them and caused so great an amount of waste as to render them very ineffective when compared with the best and newest machines.

A patent was taken out in 1794 by Mr. John Hawksley for a further improvement in wool-combing machinery, the principal features of which were: A circular revolving comb-pot to heat the combs, a "lasher or layer-on of wool" on the combing machine; also a socket or holster in which to place the combs in their respective compartments in "a readier

manner than theretofore used," for drawing off the wool from the machines. Thus, with more or less important improvements chiefly effected by Mr. Hawksley at the close of the eighteenth century, Cartwright's combing machine remained a beacon indicating the course to be pursued by future inventors toward success in this line, and the woolen industry was for many a long year to depend upon the skill of the hand-comber for the bulk of its prepared material.

Having recorded the achievements of the earlier inventors of wool-combing machinery, we now come to the transition period during which the old method of hand-combing gradually yielded place to the perfected wool-combing machinery. The change was gradual and the history of it is interesting. There were in hand-combing three operations, and these processes must have their counterpart in any machine that combs wool; more than this, as with hand-combing, some descriptions of fibrous substances could not be perfectly cleaned, even with two or three combings, and the top had to be carefully picked by hand before the final impurities could be removed; so the greatest difficulty with which the inventors had to contend was that of attaining as perfect a combing of the middle portion as of the ends of the fibre, and it was long before this difficulty was overcome satisfactorily, and in the later machines in addition to the three processes of the earlier machines and of hand-combing; namely, 1, a feeding apparatus; 2, a working comb; 3, a drawing-off movement; there is added a fourth, the combing of the middle portion of the fibres by means of an intersecting comb."

In 1805, James Noble obtained a patent for a machine for "discharging a wool comb or combs by separating the tear from the noils, drawing what was commonly called a sliver or slivers from the comb or combs, after or before the combs were worked or the wool was combed upon the same, and for other useful purposes." This invention seems to have borne no fruit, and the same may be said of those patented by Mr. Noble in 1833, 1835 and 1846. In 1871, Mr. George Gilpin obtained Letters Patent for a machine for combing and preparing wool, consisting of a framework upon which was mounted "four rings of iron, with six arms, each mounted upon iron spindles placed parallel to each other. Upon each ring four small standards were screwed to suppport the ends of wooden bars fixed parallel to each spindle, forming a frame to these bars, and to these were attached the combs. These wheels and bars were distinguished as the revolving comb frames, and the stationary and the sliding frame.

At this juncture came an important development in the Collier machine, patented in 1814 by James Collier. In his specifications he claimed to prevent loss and unnecessary labor upon "a substance which has always been considered the staple produce of this country, separating each fibre of wool, etc., so as to make them follow a direction parallel to each other,

and, by not holding or retaining them longer than is necessary to straighten the fibres, they slip through a number of points or teeth, so as to separate them from each other without breaking or otherwise injuring them." He employed in his machine "a small steam boiler to introduce steam into the inside of a taking-up roller, which was constructed of metal and made hollow, for the purpose of receiving the steam."

The next machine of importance in the progress of wool-combing machinery was one after the Collier model. It had new and extensive improvements, and was patented by Mr. John Platt, of Salford, in 1827, and was for many years known as the Platt & Collier machine, which, though more largely used by spinners than any of its predecessors, and capable of producing good results on certain classes of wools, was, in comparison with modern machines, very ineffectual, since it produced a very large amount of noils, and it was impossible to comb the middle portion of the wool at all. It is, however, extremely interesting as being a distinct advance in the right direction. See James' "History of the Worsted Manufacture" for a full description of this machine, which is too lengthy for insertion here.

Many and varied as had been the efforts of inventors to improve upon the principles of Cartwright's machine, it is to the inventive genius of Mr. Donisthorpe that the world is indebted for the practical wool-combing machine of modern times; many improvements have, no doubt, been made in this species of machine since his time, yet he it was who first made the positive success of the wool-combing machine an accomplished fact. George Edmund Donisthorpe was born at Market Bosworth in 1810; he early showed inventive genius, and at the age of fifteen he invented an improvement in the stocking frame which was universally adopted and became very valuable. In the year 1835 he was associated with Mr. S. Cunliffe Lister in certain improvements in wool-combing. He then applied all his energies to the purpose of making the combing machine of practical utility, and in 1840 took out a patent for further improvements. Two years more of incessant labor followed, and in 1842 Mr. Donisthorpe obtained Letters Patent for a combing machine of the "Cartwright order in which many valuable improvements were for the first time produced." To quote from his specifications, these were as follows: 1, teeth set at a coarser gauge at the end where they begin to work the wool and of a finer gauge where the teeth penetrated closer up to the head of the comb containing the wool; 2, the combination of working combs with combs which move in a circular or endless course; 3, an improved arrangement for filling the combs with wool; 4, in applying steam or hot water to the heads of combs placed on a revolving axis, where such combs had a movement to and from their axis of motion, in addition to their rotation, round such an axis; 5, a method of using drawing rollers having an axis only at one end, and 6, the use of two or more rotary combs with a moving, curved or endless

comb. In 1843 he took out an additional patent for three further improvements. He then entered into partnership with Mr. S. Cunliffe Lister, who was first attracted into the field by the sight of Mr. Donisthorpe's machine of 1842, and he bought the patent.

To relate the history of mechanical wool-combing in its proper sequence we must mention here the invention of Josué Heilmann, the progenitor of the embroidery machine. In 1841, Mr. Heilmann, who knew of and had seen in operation at Malmerspach the Collier wool-combing machine, arrived at the conclusion that a different system of machinery would be required for the manipulation of cotton, in which he was more interested. He is said to have discovered the principle which made his invention successful while watching his daughter comb her long hair. He applied himself to the task he had undertaken with such ardor that his first model was finished in six months, and in the presence of Messrs. Hartman, Liebach, Bourcart and Schlumberger he operated it successfully upon samples of both wool and cotton. This model is preserved in the Industrial Museum at Mulhouse. Thus was the problem of combing cotton by machinery finally solved. Heilmann's machine not only combed that material with a perfection that had never before been attained, but by the use of certain modifications it was capable of being applied to all other textile materials. This greatest invention of Heilmann was his last. "Its scope was so extensive and its principle so effective that it has been considered worthy to rank with Jacquard's famous loom. For cotton it was intended to supersede beating by hand and beaters, and to sort the filaments and reunite those of equal length; for wool-combing it aimed to supersede hand-combing, as well as the wool-combing machines then existing; for the floss of silk it would do away with the cards and combing by hand; and for flax and hemp he also hoped to obtain a more perfect method. In Heilman's machine the first operation, the feeding of the slivers to be combed, was accomplished by means of a feeding apparatus and a nipper; this nipper was the most essential point of the whole machine, and, like other important improvements in machines for specific purposes, it was made and applied by other inventors concurrently with Heilman, Mr. Lister and Mr. Donisthorpe, who in England were working indefatigably toward the production of a perfect wool-combing machine. Mr. Lister having purchased Mr. Donisthorpe's patent rights, at first alone and afterward in conjunction with Mr. Donisthorpe, he labored late and early to make the latter's machine of practical value, and in 1843 Mr. Lister succeeded at combing in Mawningham the first fine wool that was ever combed by machinery, and so successful was the operation of the machine that before the end of the year Mr. Lister received orders for over fifty machines from two of the largest spinning firms in the country. For many years, Mr. Lister commanded the wool-combing trade of Great Britain, and he received a royalty of one thousand pounds for each machine, which is said to be

the largest patent right ever before paid. The three things which it was requisite that Lister and Donisthorpe should bring about were: To make a machine that would comb perfectly; to prevent clogging, and to reduce the proportion of waste or noils accruing in the operation. There was no machine then existent that met these requirements; but by successive efforts they finally produced the "nip" machine in which the tuft of wool "was drawn by a nipper through a gill comb." In their machine the wool was drawn through the teeth of the comb horizontally; while Heilmann used a circular carder and drew the teeth through the wool in a circle. However, Heilmann's English patent was taken out in 1846, while Lister and Donisthorpe first made use of the nip principle in 1850, and not until 1851 was their machine more nearly perfected. So it comes about that the French are disposed to undervalue Mr. Lister's achievements, and in France and Germany, Heilmann is looked upon as the only originator of the "nip" system. It did not supplant Lister's wool-combing machine in England. Six Lancashire firms paid the sum of $30,000 for the English right of Heilmann's machine for combing cotton, and a Leeds firm paid the sum of 20,000 pounds for the use of the same for flax, while Mr. Lister purchased the English rights for wool; the superiority of the Lister and other wool-combing machines being proven by the fact that even after the expiration of Heilmann's patent the trade continued to pay a royalty of 1,000 pounds per machine to Lister.

We now come to an epoch in the wool-combing industry which brings us abreast with the condition of the industry as it is to-day. About 1846, Mr. Isaac Holden, who had been making investigations in the line of wool-combing, became associated with Mr. Lister, and in 1848 they formed the firm of Lister & Holden with a factory at St. Denis in France, and in 1848 also they took out a patent for a square-motion wool-combing machine which was necessarily very imperfect, but successive improvements were made until 1856, when Mr. Holden took out a patent for a machine which embodied the perfection of his idea of a square-motion wool-combing machine, the beauty of its work rendering it pre-eminent for the classes of wool upon which it was employed. From this time on minor improvements were continually effected. Mr. Holden was the first to use washing operations for wool, and he was the first to use the important process of carding as a preparation for combing at Cullingsworth in 1837.

We now arrive at the production of the Noble machine for which letters patent were obtained in 1853, since when continuous inventions of more or less importance have been applied to the Noble machine, which is thus described: "It is, in brief, merely dabbling a lock of wool on to two sets of pins placed close together, then parting the two sets so that a portion of the wool adheres to each, afterward drawing the wool thus drawn to make the combed top. The arrangement of the various parts is somewhat more complicated than in the nip comb, though the relative

adjustments are not so delicate." In Europe, the three machines which rule the wool-combing trade are: The Square Motion, the Noble and the Heilmann "Nip." The square motion is in general use in France, and is, of course, in operation at Isaac Holden & Sons' extensive works at Bradford; the Noble is the machine most widely adopted in England, and the Heilmann possesses the field in Germany. In spite of all improvements, each machine has its own peculiar drawbacks and defects. The Noble machine can only deal with prepared and not with carded wool, etc. The wool-combing machine has proved so valuable to the textile industries of Europe and America that those most prominent in its gradual development deserve all honor and admiration. In the long list that might be written of those who have done service in this cause those of Cartwright, Heilmann, Donisthorpe, Lister, Holden and Noble stand out most prominently. The list would be too long did we notice all who contributed to the perfecting of these machines, the history of which has been more fully dwelt upon in works solely devoted to that purpose. In America, we search the records of the woolen industry in vain for an earlier mention of wool-combing machinery, and find none until 1845, when we read of the New England Worsted Company at Saxonville, running sixteen sets of cards and twenty combing machines. This is due to the fact that the worsted industry is younger here than in foreign countries and in comparison with them only partially developed. There was no worsted manufacture in the United States until 1842; and as late as 1860 it was practically confined to three mills, that is, outside the carpet mills, which do not count in this particular instance, since carpet yarns and loosely twisted woolen yarns for knitting are carded alone. The procedure in preparing worsted yarn, for which long-stapled wools are mainly used, is entirely different. Worsted yarn which is made from wool fibres brought as far as possible into a level parallel condition is manufactured by one of two methods. In the first, the long yarn is drawn, gilled and combed; in the second, the medium and short stapled wools are first carded and afterward combed.

The mills mentioned were the Pacific, the Hamilton Woolen and the Manchester Mills, which were established before the wool-combing machinery was brought to perfection; but they gradually introduced the new machines, and before the close of the Civil War a number of them were in operation in this country, and conditions had arisen under which the making of many lines of worsted goods was possible; since then the growth of the industry has been very rapid in the United States, so that in 1870 the wool-combing machines had increased to the number of 261; in 1880 to 515; in 1890 to 839; and in 1900 to 1,451.

Very little worsted machinery has been made until recently in this country, the bulk of it being imported from England. A feature of the English wool-combing industry—namely, its specialization—has been inaugurated, to a certain extent, in this country by one of our largest mills.

In England it is a survival of the days of hand manufacture continued on the introduction of machinery as being the most convenient and economical system of manufacturing. Thus the enormous quantity of wool which is there woven into worsted goods passes through a few wool-combing establishments. In Yorkshire there are but about sixty combing establishments which prepare wool for hundreds of worsted and woolen mills; at Bradford the firm of Isaac Holden & Sons owns two immense combing plants, and also one at Rheims and one at Croix, near Ronbaix, in France. It has been officially stated that two-fifths of all the colonial wool sold in London is combed by this firm. On the continent the Antwerp top-market is an outlet for an immense quantity of tops, which the enterprising Belgians prepare and comb from burry Argentina and other defective wools.

Realizing that the cheapest and most perfectly combed wools were procurable only when the manufacture was specialized on a large scale, one of the foremost woolen manufacturing firms in New England, the Arlington Mills, began the production of "tops," for which they find a ready sale.

The combing machine is also applied to the preparation of cotton; Heilmann's machine being invented with that end in view, and as each combing machine has a capacity of two and a half cards, it will be seen that the advent of combing machinery greatly facilitated the cotton industry. When Heilmann's machine first came into use in 1850 it was said to be a comber for short fibres. This arose from the fact that no attempt had been made to comb cotton before that, but only the long wool fibre, and when the machines were set to combing Egyptian cottons of one and three-eighths inch staple, it was thought that this was combing the shortest cotton it would pay to comb. A demand arose in the hosiery trade for very regular and very clean yarn of coarse counts, and this primarily suggested the combing of cotton five-eighths to one and one-eighth in length, which is what is meant by short cotton. With this the Heilmann machine was incompetent to deal; first, the diameter of the detaching roll is too great to deal with such short fibres, and second, on the Heilmann comber it is impossible to get a satisfactory piecing with stock shorter than one and one-eighth inches, and it fails entirely below one inch. In fact, though the Heilmann cotton combing machine had remained without a serious rival until recently, and though the work done by it is admittedly excellent, the use of it was restricted to the finer brands of cotton spinning, as it has long been conceded that its production was small, that the piecing and overlap fall short of perfection, and that it is only effective when treating long cotton.

The Pinel-Lecœur comber was invented by Hetherington to meet these difficulties. This machine, while it reduced the waste very largely and made a fair piecing with five-eighth inch Surat cotton, was not altogether satisfactory for three reasons: First, the production was no greater than that of the Heilmann, and, although it made a better piecing in appearance, the

sliver was not amalgamated at the piecing and drawn together, but simply overlaid. Second, the waste was still too great, causing undue expense. Third, the machine was extremely complicated and necessarily difficult to set.

In the United States. combing machines, for use in the preparation of cotton, were first installed at the "Berkley Mills," Berkley, R. I., about 1875, where Edward Kilburn, desirous of producing finer goods than had previously been made in this country, put in a set or two of combers manufactured by Parr, Curtis & Company, of Manchester, England; the Ponemah Mills, of Taftville, Conn., followed this example, as did other mills during the next few years.

The first combing machines made in this country were of the Heilmann pattern, and were built by the Providence Machine Company, Providence, R. I.. in 1877, for the Elizabeth Mills, Hills Grove and Greenwich, R. I., and the Merrick Mills, Holyoke, Mass.

Later on, combers made by John Hetherington & Sons, Manchester, England; Dobson & Barlow, Bolton, England, and Plat Bros., of Oldham, England, were imported by different mills in New England. Some time about 1885 to 1890, John Hetherington & Sons brought into this country the Pinel-Lecœur comber described above, some of which were put into the Hadley Mill, Holyoke, Mass., now owned by the American Thread Company. These machines failed to give satisfaction and were finally discarded by all who had used them. Several other combers were invented about this period, but the only one to come into this country would seem to have been the Alsatian, which was built at Alsace, France, and was imported by Stoddard, Haserick & Richards, of Boston, who are still the agents (1911) for this machine. This Alsatian was specially designed for the combing of short staples, for which there was an increasing demand; it was a single-head comber, with one combing cylinder and a top comb of the original Heilmann principle; but, owing to an improved napping and piecing mechanism, it was enabled to hold, comb and piece a heavy lap, which gave it a larger production than that of the standard Heilmann type comber, built by the English firms, but the quality of the work was never considered equal to that produced by the original Heilmann type machine, because of the extremely small combing surface; but, although this machine has been superseded by superior combers, a great many of this type were sold and remained in use in 1911.

About 1890, Harry Lever, a former fitter for John Hetherington & Sons, conceived the idea of combing cotton by an entirely new principle, being financed by Mr. Redmond, of the Arlington Mills, in Lawrence. He built what was known as the Redmond-Lever comber, and four of the first machines of this type were installed in the Howland Mill, No. 2, New Bedford, Mass. This comber was designed for the handling of shorter staples with a large production, and had a detaching mechanism which advanced the lap to the cylinder intermittently, the cylinder being composed of three

small nippers that closed on the tuft advanced by the detaching mechanism in turn as the cylinder revolved. Just before these nippers closed on the tuft, the needle segment on the cylinder combed the end nipped by the nipper, and as the tuft was carried forward by the cylinder it was combed by the top comb, and after passing the top comb it was pieced to the tuft which had gone before and drawn through the rollers called the piecing rollers, from thence into a conductor or cylinder pan up to the table or silver plate in the usual way, and through a draw box, as in the Heilmann type comber. This was the second comber that was built in this country, and was really an American invention; but it was never completed.

About 1895 the Mason Machine Shops, of Taunton, Mass., designed and built a comber which was almost an exact counterpart or duplicate of the Heilmann comber, and they have perhaps a hundred of these machines in active use to-day. About the same time the Mumford comber, built by Glabasch & Mumford in Germany, was brought to this country, and was strongly recommended as a high-production comber for short staples. The Mason Machine Shops secured the agency for this machine and a license to build it in America. This comber had a detaching mechanism which delivered the cotton to the cylinder intermittently, with a nipper separate from the cylinder, somewhat like the Heilmann comber, which held the cotton while the cylinder combed the tuft, and directly over the top of the cylinder there were two piecing rollers which revolved in the piecing segment after the combing of the tuft, which advanced the tuft combed to the opposite side of the cylinder, where it was nipped again, and the rear end of the tuft was combed by the same combing cylinder in the revolution of the cylinder. This machine was considered a failure, and of those installed in this country few, if any, are in operation. In 1897 the Whitin Machine Works, of Whitinsville, Mass., built a comber which was an exact duplicate of the Heilmann type, and their first machine was installed at the Paul Whitin Mfg. Co., Northbridge, Mass., and proved so successful that in 1900 they equipped one department of their works for the manufacture of this comber, and the first eighteen were built for the New York Mills at New York Mills, N. Y. This type they continued to build until 1905. The standard Heilmann comber up to that period was a six-head comber, running a lap eight and three-quarters wide, with the exception of a few machines that were built by Platt Bros., Oldham, England; John Hetherington & Sons, Manchester, England, and Dobson & Barlow, Bolton, England, which used a lap of the following widths: eight and three-quarter inches, ten and one-half inches, twelve inches. These machines were built in six and eight heads, but were not universally adopted, owing to imperfections caused by vibration.

Previous to this, Messrs. Dobson & Barlow had produced the Double Nip Comber, which was considered a high-speed comber, the claim being 125 nips per minute instead of eighty to eighty-five, as in the single nip

machines. John Hetherington & Sons also secured letters patent on a double nip comber. A few machines of this type were shipped to New England, principally those of the Dobson Barlow make; but their defects were such as to prevent their adoption, the extreme vibration making it impossible to retain the settings, and in designing the machine two needle segments had been added to the cylinder, which reduced the combing surface from seventeen to thirteen rows or needles.

Next came the Nasmith comber, invented by John Nasmith, of Manchester, England. This machine was to some extent of the Alsatian type. In it the piecing principle was somewhat like the Mumford comber, and it retained all the best points of the Heilmann, while its defects were eliminated; it had a maximum speed of ninety-five nips a minute, combing a medium-weight lap; that is, an increase of about fifty per cent. in weight of lap over the Heilmann type comber. In 1901-02 a few of these Nasmith combers were brought into New England mills, and were later taken out and replaced with an improved Nasmith machine, which, in 1904, were replaced by the Nasmith Patent Comber, built by John Hetherington & Sons, Manchester, England, imported by S. C. Low, of Boston. This machine occupies the same floor space as the Heilmann, and its production is double that of the latter at the same speed, and it combs without undue waste all staples from seven-eighths to two inches, making a perfect piecing with the shortest fibres, and it does fine medium and coarse combing. "In all combers, except the Nasmith, the piecing consists simply of laying the tops of one lot of fibres over the tails of the previously detached series, the overlap being about one-half of an inch on long cottons, and with short cottons no sliver can be made that will hold together along the table. But the nature of the piecing in the Nasmith is quite different, there being not only a long overlap, much exceeding the length of the staple on the short cottons, but the ends are thoroughly amalgamated by being drawn in while the overlap is being made. This does away with the serious difficulty of manipulating the combed slivers at the subsequent operations, and makes such operations quite normal in character, causing neither excessive waste nor stoppage."

So successful did this comber prove that, in 1908, 2,000 of them had been placed upon the market, over 500 of them being in various mills in America. Meanwhile, the Whitin Machine Company, recognizing the fact that there was a growing demand for a higher production comber, that would deal with shorter staples, set themselves to meet it by producing a comber in which the vibration would be greatly lessened. First they built an eight-head comber, running an eight and three-quarter lap; this fell short of what the manufacturers required, and it was improved to an eight-head comber, using a ten and a half lap. One hundred and sixty of these last machines were installed in the Manomet Mill No. 1, New Bedford, Mass., eighty machines were put in the Kilburn Mills, New Bedford, Mass., and

100 additional combers were built and placed in small lots in various mills throughout New England. In the Manomet Mills Texas cotton one and one-sixteenth staple and seven-eighths cotton were both successfully manipulated.

In the fall of 1904 the experimental force of the Whitin Machine Works turned their attention once more to the improvement of the Heilmann type comber, working on the plan of improving the machine by diminishing the vibration without interfering with the principle of the Heilmann comber, and six months later they placed upon the market the result of their labors, the Whitin High Speed Comber, built in eight heads, using a twelve-inch lap, the machine occupying the same floor space as the eight-head comber using a ten and one-half inch lap. The new machine had a minimum speed of 125 nips per minute, and an exactly proportionate production of two and one-half times that of the standard six-head, eight and three-quarter lap Heilmann comber, while the quality of the work remained the same. The arrangement of the feeding, piecing, nipping, combing and detaching operations is the same as in every Heilmann single-nip comber, the vibration of the comber being overcome in the following different ways: (1) By eliminating entirely the rocking motion of the nipper frame and fixing it in the correct position for combing. (2) The lifting mechanism of the top detaching rolls is eliminated and the top roll is raised and lowered for piecing by a bevel on the cylinder shaft segment, this motion being much more positive as the roll is raised up gradually instead of being dropped. 3. A tension device is appplied to the brass detaching rolls to prevent skipping. 4. The most important improvement is that the actuating mechanism of the lower detaching and piecing rolls is designed so as to use two notched wheels instead of one as heretofore, with their accompanying internal gear. One of these notched wheels is working through the movement of the actuating cam on the cam shaft, while the other notched wheel is resting, to take its turn the following nip and so on. Thus, to drive the drawing-off rolls there are supplied two actuating mechanisms, each one of which runs at one-half the speed it formerly did with the same number of nips." These, with some few minor changes, produced a comber which met the requirements of the trade, and in 1910 the Whitin Machine Company had built and put upon the market over 2,500 combers. The Whitin High Speed Comber is also built in England by Messrs. Howard & Bullough, of Accrington, for use in that country and on the continent. The high quality of the product is maintained, the loss is minimized and a high grade of yarn from short staple can be produced at less cost to the manufacturer by this machine. One of the principal points of interest to the mill owner was the fact that he was enabled to equip his mill with an adequate combing plant without excessive cost, owing to the increased production of the machine, a consideration which was augmented in 1908, when it became necessary for the manufacturer to employ shorter staple. The Whitin high speed

comber also met successfully the necessity for a system of semi-combing to take the place of double-carding, which had been used to some extent in New England mills. The double-carding of fibre weakened the stock, which was considered defective, and of course this placed again before the manufacturers a very interesting proposition, as in the semi-combing of staple, instead of double carding it the manufacturer was able to use one-sixteenth shorter staple, which saved from one to three cents per pound in the cost of his raw stock. The Whitin High Speed Comber also met the demand of the manufacturer for a machine that would reclaim long fibres from the waste made by carding and combing in the ordinary fine mill; where combing and carding were done in a mill, it would decrease the waste account from twelve to fifteen per cent.; where carding only was done, there would be a decrease in the waste account of about three per cent, and this saving was of vast moment to the manufacturer because of the high price of staple cottons used in a fine mill and the immense quantity of stock used in a coarse mill.

We now come to the second division of our subject—namely, carding. The hand card was really more in the nature of a brush having wire instead of bristles. The old hand cards were made of wood and were usually about one foot long by five inches broad, having a handle about in the middle, and were covered with card clothing, the latter being composed of thin leather into which was inserted a great number of short wires about one-half an inch long; the wires being bent at a point about midway from the point of their insertion, in order to give them a certain degree of elasticity, while the points were ground to a certain shape, in order that their purpose might be effected. The process consisted in holding one of the cards stationery between the knees of the carder, who, after filling it with as much wool as could be conveniently worked, brought the points of the other card into contact with those containing the wool; the second card being held so that its points were turned in the direction opposite to those of the wool-filled comb, the operation being continued until the different lengths of wool fibres were sufficiently opened and mixed, after which the two cards were held in a vertical position; they were then operated in a gentle manner, with the teeth of the two cards all pointing in the same direction, until the carded wool was made into a roll equal to the length of each card which was now ready for the spinning wheel; such was the *modus operandi* of hand cards. It is said that stock cards were first applied to the preparation of cotton in England in 1739.

The first improvement effected in carding consisted in making one of the two cards a fixture and increasing its size so that the carder, having spread the cotton or wool upon it, might use a card double the size of the old cards and do twice the amount of work. "The process was further facilitated by suspending the movable card by a pulley from the ceiling, with a weight to balance it, so that the workman had only to move the

card without sustaining its weight." These were called "stock cards" and were first applied to the manufacture of woolens. John Wyatt spoke of the carding of cotton with stock cards in 1739. The invention of spinning machinery now made it necessary to improve and facilitate the methods of preparing the fibres to be spun, a need that was met in part by the application of the rotary principle to carding by Lewis Paul, the inventor of roller spinning. The patent which he took out August 30, 1748, includes two machines for acccomplishing the same purpose; the one a flat, the other a cylindrical arrangement of cards The same specification applies to both: "The said machine for carding of wool and cotton, etc., does consist and is to be performed in the manner following, to wit: The card is made up of a number of parallel cards, with intervening spaces between each, and the matter being carded thereon is afterwards took off each card separately, and the several rows or filaments of wool or cotton so took off are connected into one entire roll." Of the two machines the second was the more important, consisting, as it did, of "a horizontal cylinder, covered in its whole circumference with parallel rows of cards with intervening spaces, and turned by a handle." Beneath this cylinder was a concave frame, lined internally with cards, exactly fitting the lower half of the cylinder, so that when the handle was turned the cards of the cylinder and of the concave frame worked against each other and carded the wool." This undoubtedly bears resemblance to the modern carding cylinder, except that in the modern machine the concave frame is placed over the cylinder instead of under, as in Paul's machine, which had a contrivance for letting the concave part down by a lever and pulley and turning it round, that the carded wool might be easily stripped off, which was done "by means of a stick with needles in it, parallel to one another, like the teeth of a comb." An ingenious device was introduced for the purpose of forming the cardings into a perpetual strip; this consisted of a flat, broad ribbon, extended between two short cylinders, which wound upon one cylinder as it unwound from the other. The carding being placed on the ribbon, the turning of one of the cylinders wound the ribbon and carding upon it and thus formed it into a roll ready for the spinning machine. Admirable as was this invention, it was defective in several important points; the cylinder had no feeder, the cardings were taken off separately by a movable comb, and the perpetual carding was produced by joining short lengths by the hand as we have described, where now a comb attached to the cylinder, and constantly worked against it by a crank, brings it off the machine in a continuous roll.

After the breaking up of Wyatt and Paul's establishment at Northampton, the machine was brought and set up in Leominster and was applied to the carding of wool for hats and later on was taken to Wigan, in Lancashire, in 1760, and there applied to cotton, Mr. Peel being one of the first to adopt it. The first improvement in the carding machine was the fixing of a perpetual revolving cloth called a feeder, for which improve-

ment a patent was taken out by John Lees, a Quaker of Manchester, in 1772. Arkwright claimed numerous important improvements in this machine later, many of which were sharply contested by contemporary inventors.

But though many of the improvements were really effected by him, and though, in some large measure, the perfection of the carding engine into a complete and beautiful machine which has proved incapable of improvements up to the present day was due to him, the leading principles of it were really due to other and less fortunate inventors. When Arkwright took out his patent for carding, he also included in it machines for drawing and roving. In December, 1775, Mr. Arkwright took out a further series of patents for carding, roving and drawing machines, all to be used "in preparing silk, cotton, flax and wool for spinning."

The first carding machine in use in the United States was built by Arthur Scholfield, who came from England in 1789 with his brother John and went to Byfield, near Newburyport, Mass., where they constructed the first carding machine for wool that was operated in the United States. Later, Arthur removed to Pittsfield, Mass., where, in 1800-1, he built a carding machine and set up for himself as a woolen manufacturer, and also as a builder of carding machinery, as may be seen from an advertisement which appeared in a Pittsfield paper in 1806: "Double-carding machines, made and sold by A. Scholfield for $253 each, without the cards, or $400 including the cards. Picking machines, $30 each." Carding machines made by him were set up in Lenox in 1806, and in Williamstown in the same year, and in Cheshire in 1807. Mr. Scholfield also introduced the carding machines into Connecticut, New Hampshire and other states.

It is now necessary to give an account of the inventions and improvements during the next century of an industry in which Americans were from the first pre-eminent—namely, the manufacture of card clothing. As early as the period of the Revolutionary War there were in existence several manufactories for the making of cards. Daniel Anthony had one at Providence, R. I. The colony of Connecticut, in 1775, granted a loan of $1,500 to Nathaniel Niles, of Norwich, to enable him to carry on the manufacture of fine iron wire for card teeth. Iron at this time being very costly and hard to procure, Jeremiah Wilkinson, a hand cardmaker of Rhode Island, set to work to make tacks for clothing by cutting them from sheet iron with a pair of shears and hammering heads on them with a vice.

One of the earliest inventors of a machine for the manufacture of card teeth was Oliver Evans, of Philadelphia; his business was that of making card teeth by hand, and he contrived an ingenious machine capable of making 1,500 teeth a minute; he met with so little encouragement, however, that he sold his machine and plans to other parties. Other improvements devised by him for pricking the leather and cutting, bending and setting the teeth he abandoned in discouragement, but they were taken up by others and formed the basis for subsequent patents.

Giles Richards, who built a factory near Windmill Bridge, Boston, is supposed to have applied Evans' inventions to machines which he worked by a windmill. One of these machines tended by one man would cut and bend the wire for 240 cards in twelve hours. This factory was inspected by Washington during one of his Eastern tours. There were at that time 900 persons employed in the mill, where they made 63,000 pairs of cards per annum. President Washington, writing of these machines in 1789, describes them as "executing every part of the work in a new and expeditious manner, especially in cutting and bending teeth, which are done at one stroke."

The machine of Chittenden, of New Haven, produced about 1784, took the wire from the coil, cut it into teeth and gave them "the first or double bend." It made 86,000 teeth in an hour and was very likely utilized by Mr. Richards in conjunction with the machine of Evans. Mark Richards, brother of Giles, was engaged extensively in the making of cards near Faneuil Hall, Boston, in 1794; there was also a factory operated by Amos Whittemore which supplied four-fifths of the cards made in the state.

In 1785 Edmond Snow began the making of hand cards at Leicester, Mass.; this was the foundation of an industry which later brought commercial prosperity to the town. One of the greatest obstacles with which Samuel Slater was confronted in 1789 was the difficulty of obtaining sufficient properly made card clothing for his carding machinery. Fortunately at this juncture he met Phinney Earle, who, since 1786, had been engaged in the hand-card business at Leicester, Mass., and engaged him to make the card clothing for the machines. In order to comprehend the difficulties of this new and untried experiment, we shall describe the usual method of making card clothing at that date, in order that we may contrast it with the requirements of the new venture. A strip of leather was taken, four inches wide and fifteen to twenty inches long and ruled off into quadrilateral sections. "Two holes were made at a time at the intersection of the lines by a double-needled pricker and the two-pronged staples which had been previously bent in a machine were inserted into the holes one at a time by hand. The second bend in the staple then being made, the card was tacked on a board ready to be used for carding either wool or cotton. Now for Mr. Slater's cards: strips eighteen by four inches were cut from sheets of calfskins; one hundred thousand holes were then pricked with the implement made for that purpose, and the teeth, which had been made by machinery, were put in by hand. The teeth in these cards were set diagonally, which suggested to Mr. Earle the invention of a machine for pricking "twilled" cards, for which he obtained a patent, December 6, 1803. Mr. Earle at first used calfskin, but later adopted cowhide, which was especially tanned for the purpose; still later many other materials were used, and in a modern and well-equipped card manufactory all kinds of card clothing are manufactured and used, including oak and hemlock tanned

leather, a dozen varieties of rubber-faced card clothing and a dozen or more varieties of cloth card clothing, and the iron wire teeth set by hand have been superseded by soft steel wire in about twenty sizes; hardened and tempered steel wire, in a dozen different sizes, as well as tinned wire and brass wire in different sizes. But we must retrace our steps to speak of others prominent in the growth of the carding industry. Eleazar Smith, of Walpole, conceived a machine for making cards that would combine the operations of bending the teeth and pricking the holes in the leather. Many of his experiments were made under the patronage of Mr. Hale; but, after 1784, he was employed in the card works of Giles Richards & Company and remained with them nearly two years, during which time he effected several improvements in card-setting machinery. He then, under his own roof, began to work upon his "grand machine to stick cards." Those interested in card clothing visited him from time to time, and in the simplicity of his heart he explained to them the details of his machine now nearing completion. "It consisted of an iron bedplate, twenty-four inches square, with wrought-iron posts for the centre and working parts." He had succeeded in making it prick the leather, make the teeth and set them in straight and was about to apply his ideas in putting on the second bend to the teeth, when he heard of the patent granted to Amos Whittemore in 1797. The man who had been his most frequent visitor and had followed him in all the workings out of his machine had forestalled him. A disappointed and broken-hearted man, he never recovered from the blow.

Mr. Whittemore was a skilled mechanic and possessed of great inventive faculty, and he probably had his own well-laid plans for the perfecting of his own machine, and had he not so constantly visited the workshop of a rival as skilled as he, but handicapped by poverty, more honor could have been accorded him for the invention of a machine that was a splendid specimen of "construction, precision of movement, rapidity of performance and perfection of execution, it must be studiously examined to be justly appreciated, and its complicated performance can be compared with nothing more nearly than the machinery of the human system."

In 1809 the patent was renewed by Congress, the vote on the petition being fifty-five to eighteen. Other inventors have since made valuable improvements in card-making machinery; namely, Elliott, Lamb, Porter, Sargent, Coates, W. B. Earle, Addison and Oliver Arnold, Ballard, Ainsworth, McFarland, Conklin, Prouty, Woodman, etc.

The most prominent of the American inventions relating to the carding machine itself is that of John Goulding, which marked almost as great an advance in woolen manufacture as the spinning jenny itself. The Goulding machine was first introduced about 1824. Prior to this invention the rolls issuing from the carding machines were limited to the breadth of the card, the ends of the roll being spliced together by hand or by means of the billy. With the latter Goulding dispensed entirely, and so managed to

accomplish with four machines what had formerly been done with five. His machine afforded an endless roll or roping, and lessened the cost of production, while increasing the quality and quantity. After 1830 no new sets of cards were started on the old plan of manufacturing. The forty-inch cards began to come into use about this time; in the old carding engines the width was twenty-four to twenty-six inches, a few being twenty-eight inches wide. The speed of the machine was also accelerated from seventy-five revolutions a minute to eighty-five and one hundred. In England the cylinder cards are preferably used, while in America the flat revolving card is most in vogue. (See Plate 4.)

THE HISTORY OF SPINNING

BY WILLIAM F. DRAPER

Spinning as an art cannot be traced to its earliest conception, as it dates back of all existing records and traditions. The mummies of Egypt confront us wrapped in linen of superior texture, and in every nation the first advance toward civilization began with the use of woven fabrics.

The production of cloth of any kind requires the production of yarn in advance. Spinning is the art of producing yarn, and consists in methods of twisting vegetable or animal fibres into a continuous thread. This invention has been discovered at different times by every intelligent race, and Columbus, when first landing on American soil, found the natives clad in cotton cloths.

To-day in different sections of the world every step in the development of the now nearly perfect spinning machinery may be found in actual use —the native Mexican, with her distaff, toiling not many miles distant from the Rabbeth spindle in a cotton mill. Whether the latter will stay in use as long as its older rival time alone can determine; but there is no question but that it has already twisted more yarn, in its thirty years of existence, than the distaff in its thousands.

The amount of human labor saved by modern invention in this line is enormous. The prime necessities of life are food and clothing; and, although no development of inventions is likely to increase the capacity of a man's digestive apparatus, the amount of cloth he uses increases with his purchasing power. This is an industry which affects every class of people. It furnishes employment for men, women and children, who in turn consume its product. No other industry can have a greater interest for the mass of the people, and the development of few others can affect them to the same extent.

When the spindle was first used is unknown, but the spindle and distaff are mentioned in the earliest references to mechanical art.

Spinning for many centuries was done by what is known as the distaff, which was simply a short stick, on one end of which the raw material was placed, while the other was held under the arm, thus leaving the hands at liberty, one to draw the material and the other to manage the spindle. The accompanying spindle was a stick, perhaps a foot in length, having a slit or catch in the top, and a whirl of wood or metal at its lower end. The yarn being held by the slit, the spindle, suspended in the air by the yarn,

was rotated by the right hand to put in the twist, the yarn being wound upon it as fast as a length was spun.

In 1530, the spinning-wheel was introduced into Europe. It was made after the spinning-wheel which had been in use in India from immemorial times. The spinning-wheel about the time of Henry VIII was used in almost every household in England. Every young woman, whatever her position in life, was taught to spin with this machine; hence the origin of the term "spinster," as applied to an unmarried female. (See Plate 5.)

The spinning-wheel was a horizontal spindle, rotated by a band from a large hand wheel, the yarn being drawn through the fingers of the operator, as before.

A hand spinner with a spinning-wheel was said by Mr. Chauncy Smith, in his "Influence of Inventions on Civilization," to be able to spin a single thread about four miles long per day, or eight skeins. This I believe to be a very high estimate; but, assuming its truth and calling a day twelve hours, each spindle in a Rabbeth frame on 30's yarn would spin about the same amount, and, if the yarn were coarser, more. And so spin six times that amount at a cost of one and one-tenth cents per week for labor. Even the Hindoo spinner, at five cents a day, would make the labor cost thirty times as much with the spinning-wheel as it costs in one of our modern frames at the rate of wages paid in American factories. One spinner, tending a thousand spindles, does the work of more than a thousand spinners with the old-fashioned spinning-wheels not much more than a century ago.

Early in the eighteenth century experiments looking towards a more rapid production of yarn began to be frequent, the first practical invention for this purpose being a roller spinning machine, made by John Wyatt and patented by his partner, Lewis Paul, in 1738, the principles of this machine being embodied in Arkwright's patent of 1769.

In 1767, James Hargraves invented the spinning jenny, which was practically the application of the spinning-wheel principle to a number of spindles, together with a reciprocating motion of the spindles to and from the point where the material is delivered, as in the mules of the present day. The spinning, as in the mule of today, was intermittent, rather than continuous. (See Plate 5.)

In 1769, Richard Arkwright invented the first continuous power spinning machine, which was intended, as stated in his specification, "to receive its motion from a horse." This was a flyer structure, on the general principle which continued in use for nearly a hundred years. It is in use to-day to a limited and constantly diminishing extent.

These machines were received with great disfavor by the people, who thought they saw their occupation gone if one spinner could do the work of a large number; and at one time preconcerted mobs broke up all the spinning machines in Leicester having more than twenty spindles each.

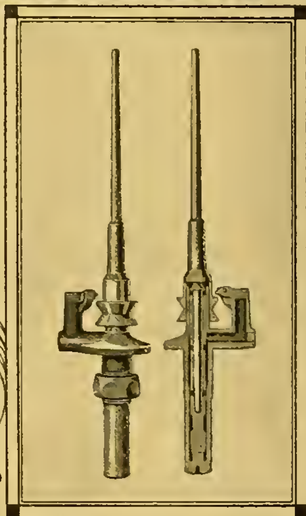
PLATE V—Spinning

1


2


3


4


6


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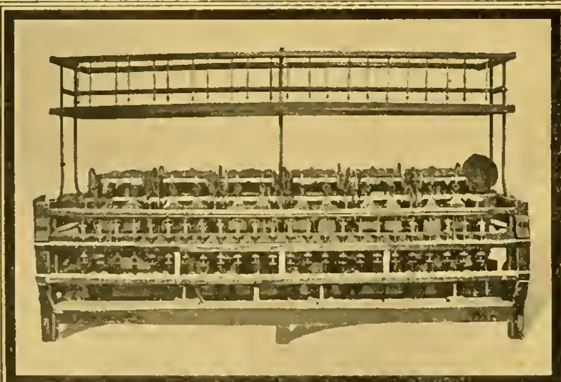

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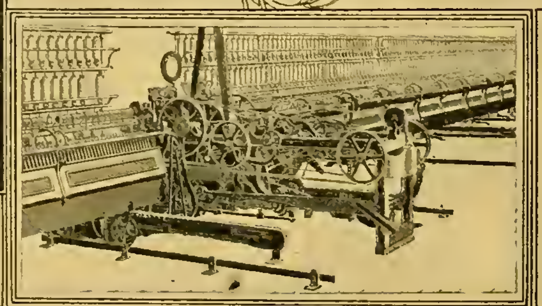

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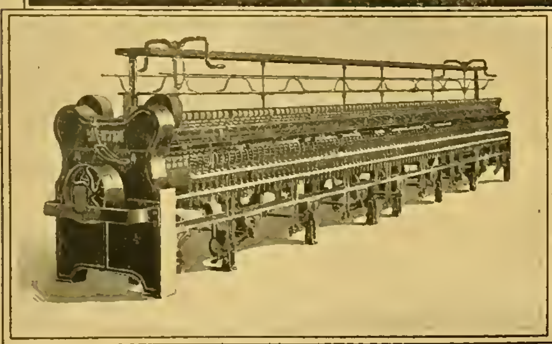


7


1. Early Method.
2. From 14th Century M. S.
3. Roman Spinning.
4. Then and Now.
5. Slater's First Spinning Frame. (Now in the National Museum, Washington, D. C.).
6. Spindle.
7. Hand Mule Spinning.
8. Power Mule Spinning.
9. Ring Spinning.

JAMES H LAMB CO

No more absurb illustration could be given of the foolishness of the opposition of labor organizations to labor-saving improvements. The demand for labor has probably been as much increased by the invention of the "spinning jenny" as the cost of cloth has been diminished by it.

The Arkwright machine was called the "water frame," from the fact that, although the first ones were driven by horse-power, it was later on driven by water-power. This machine was gradually perfected, and became known as the "throstle" or "flyer frame." It underwent various modifications, and became the standard machine for spinning warp all over the world.

In this machine the sliver, passing from the drawing rolls to the bobbin, passed around the arm of a flyer, which was revolved some three or four thousand times a minute, thus giving twist to the yarn. The bobbin received motion from the flyer through the yarn, and had a speed equal to that of the flyer, less the number of revolutions required to wind the spun yarn upon the bobbin. Inasmuch as the system of spinning with a flyer had been used with a form of hand wheel known as the "Saxony spinning-wheel," that does not constitute the chief element of Arkwright's invention, but the system of drawing the fibre by rolls driven at different speeds, which is the universal custom at the present day.

Two kinds of flyer frames were in general use—the live spindle-flyer and the dead spindle-flyer. The live spindle-flyer moved with the spindle, and the bobbin rested upon a drag carried by the traverse or copping rail. The dead spindle-flyer, an American invention, took its upper bearing in a plate above the spindles, and its lower bearing upon the dead spindle itself. The bobbin rested on a washer on the dead spindle, and revolved with it. The principle of spinning was the same. The yarn was wound upon the bobbin by the falling behind of the latter in speed, as compared to the speed of the flyer.

The flyer frame made strong and satisfactory yarn; but, owing to the rapid revolutions of the flyers through the air, a great deal of power was consumed, and the speed was limited to about 4,000 turns per minute, owing to the tendency of the flyers to spread. The dead spindle-flyer was the one most extensively adopted in this country.

In the year 1779, Samuel Crompton, of Lancashire, England, invented the spinning mule. His first machine contained only forty-eight spindles. The principal feature of his invention was the movable carriage, by means of which the action of the left arm and finger and thumb of the spinner on the ordinary spinning-wheel, were reproduced. (See sketch of Samuel Crompton, *Ibid.*)

In the year 1828 the first patent that I find on a ring-spinning frame was issued to Mr. John Thorpe, of Providence, R. I. A few years later, patents on ring frames were issued to Mr. Samuel Brooks, of Baltimore, Maryland, and to Mr. George H. Dodge, of Attleboro, Massachusetts.

Evan Leigh, in his "Modern Cotton Spinning," says that ring spinning was said to have been invented by Mr. Jencks, of Pawtucket, Rhode Island. There seems to be no certainty on this point; but whoever the inventor was, he certainly has conferred a great benefit upon the human race. (See Plate 5.)

In the ring spinning frame the flyer is dispensed with, and the bobbin is carried with the spindle, and at the same speed. On the traverse rail is fastened a flanged ring, which is made as hard and as smooth and as nearly round as possible. On this ring is sprung a small piece of steel wire, bent in a half circular form, with the ends turned in, called a "traveller." The yarn, in going from the rolls to the bobbin, passes through this traveller; and the drag, or winding on, is obtained by the falling behind of the traveller in speed, as compared with the speed of the spindle and the bobbin. Different travellers are used for different sizes of yarn, and the yarn may be wound more or less compactly upon the bobbin by varying the weight of this traveller, and thus increasing the drag and the friction on the ring. The ring and traveller have a reciprocal vertical motion, and wind the yarn as fast as it is spun in layers upon the bobbin.. The revolution of the spindle gives motion to the thread attached to the bobbin, and through that to the traveller.

The speed of the spindle and bobbin are greater than the speed of the traveller by the number of times that the yarn is wound around the bobbin. The amount of twist in the yarn is equal to the number of revolutions of the traveller while a given length is being spun.

By doing away with the flyer, the power required to drive the machine was greatly reduced and the speed increased, so that the frame as a whole was much more effective. It was rapidly introduced in America, until in 1860 the larger number of spinning frames in use were ring frames. The flyer as still largely run on coarse work, and some mills were equipped with the Danforth or cap frames.

Manufacturers were divided in preference between what was known as a positive drive spindle, which carried a loosely fitted bobbin by a pin, and the spindle with taper blade, which carried the bobbin by frictional contact. Each form had its advantages; but the tapering spindle, carrying the bobbin by frictional contact, became, ten years later, the standard structure.

At this time the ordinary weight of the spindle varied from twelve to sixteen ounces, and the most rapid speed was 5,000 revolutions per minute. At this speed from seventy to a hundred spindles were ordinarily run by one horse-power. (See Plate 5.)

During these ten years successful efforts were made by various builders, particularly by Mr. John C. Whitin, of the Whitin Machine Works, and Messrs. Fales & Jenks, of Pawtucket, Rhode Island, to reduce the weight of the spindle, and consequently the power required to

drive it. The spindles were reduced in weight to eight, and in a few cases even to six, ounces, with some saving of power; but the speed could not be increased, as the lighter spindles sprung in rapid revolution more than the heavier ones before used, and were more likely to throw off bobbins in spinning. The twelve-ounce common spindle was the best of that type for durability and steadiness of running.

In 1871, an invention in spindles was patented by Mr. Jacob H. Sawyer. then agent of the Appleton Mills, at Lowell, which entirely revolutionized spinning, and was one of the most important inventions of the time.

He conceived the idea of chambering out the bottom of the bobbin, and carrying the bolster up inside, thus supporting the load which the spindle had to carry near its centre. This change in support of the spindle enabled it to be greatly reduced both in weight and diameter of bearings, and the saving in power was enormous. The steadiness of running was also materially increased by the location of the upper bearing, and this enabled the speed of rotation to be increased also.

As the speed which the spindle would bear was at this time the limit of the production of the frame, an increase in capacity for speed in the spindle meant a corresponding increase in the production of the machine.

While with the common ring spindle the speed was usually about 5,500 turns a minute, with the Sawyer spindle it was raised to 7,500 turns per minute. At the same time a horse-power would drive about 175 Sawyer spindles at the higher speed, while it would drive only about one hundred common spindles at the lower speed.

This increase in production and saving in power, together with many other incidental advantages, caused the very rapid introduction of these machines. Over 3,000,000 were sold in the ten years succeeding their invention, when this spindle was superseded by one of even greater capacity.

During these ten years, the Sawyer spindle underwent considerable modification and improvement. Mr. George Draper, and others connected with him, corrected the faults one by one, until the Sawyer spindle in the latter years of its extensive sale seemed to have reached mechanical perfection. It was far better calculated for rapid revolution than any spinning structure ever before made, though not equal to the various forms of the Rabbeth spindle now in general use.

In the year 1878, after long experimenting, Mr. Francis J. Rabbeth placed on trial his so-called "top" or "self-centring" spindle in the shop of Messrs. Fales & Jenks, of Pawtucket, Rhode Island.

The particular features of this so-called "top" spindle were: First, the sleeve whirl; second, a loose bolster, supported in a tube which held both bolster and step bearings, and formed an oil reservoir to lubricate them; third, the elastic packing, ordinarily composed of woolen yarn, which surrounded this bolster, shown in the cut at D; fourth, the flat top step, on, rather than in, which the rounded bottom of the spindle moved with the

bolster; fifth, the snout oil chamber, which ensures a better supply of oil, and keeps the reserve at a higher level than any other form yet tested.

The spindle was called the "top" or "self-centring" spindle, on the theory that the spindle acted like a top, and found its centre of rotation under an unbalanced load. This theory has since been discarded by experts, it now being thought that the advantages of the Rabbeth spindle are derived, first, from the cushioning effect of the loose bearing; and second, from the additional cushioning effect of the packing interposed between the bolster bearing and the surrounding case, both taken in connection with a sleeve whirl surrounding the tube containing the bearings. The spindle does not centre itself, but runs out of centre with less jar and vibration and heat, and thus is enabled to bear a greatly increased speed, and to run with less power.

Various modifications of the Rabbeth spindle have gone into extensive use—the Whitin, the McMullan and the Sherman being the principal varieties. The great difference between them and the Rabbeth lies in the elimination of the packing and the positive restraint of the bolster from turning. The Rabbeth spindle, in a modified form named the "Draper," from the author of this article, is one in largest use to-day.

The gain to the community from the development of spinning since the day of the distaff is so great as to seem impossible.

Twenty-five million of the various types of the Rabbeth spindle have been sold in this country, and must be substantially all in use. Allowing a spinner to a thousand spindles, there are twenty-five thousand spinners employed in running these spindles to-day. To spin the same amount of yarn on spinning-wheels, which are a step ahead from the distaff, would require the labor of more than twenty-five million spinners, or probably one-third of all the men, women and children in the country, three hundred days each year. In fact, it is doubtful if our entire working population, outside of those engaged in the production of food, could provide our present consumption of yarns with the tools of one hundred and fifty years ago. The same comparisons could be made abroad with similar results in all the machine-using countries, but I have not room to enlarge.

I will, however, make a brief calculation of the value to this country of the spindle inventions adopted since the year 1870,—calling the speed of the then common spindle five thousand,—a high average,—and that of the Rabbeth, nine thousand, though many of them are run more rapidly. The production per spindle has increased more than the increase in speed, but I will base my figures on the difference in that factor alone.

Twenty-five million Rabbeth spindles will produce as much yarn as forty-five million of the spindles of 1870. It follows, therefore, that had the improved spindles not been introduced, twenty million more common spindles would have been required to produce the yarn now spun in this country. The cost of spinning frames to-day, including floor space occu-

pied and plant for shafting, heating, lighting, belting, etc., would not be less than $4.50 per spindle. At this figure, therefore, the saving in plant has been $90,000,000.

Further, the old spindles, at 5,000 turns, required as much power as the latest Rabbeth at 9,000, so that the power required to drive 20,000,000 spindles has been saved. At one hundred spindles to the horse-power this would amount to 200,000 horse-power, which, at $20 per horse-power—a very low estimate—would make a saving of $4,000,000 each year.

Again, owing to the better running of these spindles, they require no more attention at the high speed than the common spindles at the low speed. The labor cost for spinning, including all employees from the spinner to the overseer, is not less than sixty cents per spindle per annum. The labor cost saved yearly, therefore, is $12,000,000.

Capitalizing these gains at ten times the yearly saving, and omitting minor advantages, the annual gain to the community from spindle improvements introduced since 1879 is shown by the following figures:

Saving of Machinery	$90,000,000
Saving of Power	40,000,000
Saving of Labor	120,000,000
Total	$250,000,000

And this is the saving in this country alone on the machinery now in use.

The tendency of the United States is to use ring rather than mule spindles, which are used only for those classes of yarn which cannot be produced by ring spindles. The number of active ring spindles in the United States for 1910 was 24,192,359 ring and 4,996,586 mule spindles. In the United Kingdom the ratio is inverted, and only about twenty per cent of the total number are ring spindles.

YARN AND THREAD WINDING

BY F. H. BISHOP

Before the beginning of history, when the primitive man or woman drew out the fibres of wool, or goat hair, and twisted them between the fingers and first made a cord, the necessity of forming some kind of a package could have resulted only in three generally different characters of bundles or packages. Naturally the first disposition of the material was to fold it in coils, forming what is now termed a "hank." Later, collecting the first short coils into a mass and then winding thereon in different directions a ball would have been formed, and in process of time some more daring innovator than his fellows bethought himself of a rigid core upon which to wind the material, taking a stick and laying the yarn coil after coil, spool fashion, or else in the manner called ball fashion.

It was undoubtedly much later in the development of the art that a considerable advance was made which consisted in laying the yarn in successive coils one above the other, so as to build up a generally symmetrical mass with flat ends, and, so far as we have any evidence upon this point, this was only done as late as the time of the later Fiji Islanders, who, after an indiscriminate winding of the cords into a cylinder, finally disposed it with the outer coils alternating cross-wise, forming an ornamental exterior which corresponded to the single ornamental layer of cross-coiled strands which they laid upon their oars and spears to secure a better hand grasp thereon.

With the introduction of machines for winding threads, yarns, ropes and cords, the coils of different kinds were laid more regularly, yet it is a surprising fact that so far as the structure of the packages themselves were concerned there was practically no radical departure from the prehistoric methods of building the packages until within the past fifteen years.

While the structure of the modern packages has thus assimilated those of prehistoric times, the advance in the character of machines for winding was for a time rapid, and resulted in such modifications of the forms of the packages as were embodied in spooling, in the products of spinning machines, and in warp windings for looms, etc.

The machines which were developed for these purposes may be divided generally into four classes—that is, reels, spooling machines (including those which would wind cops for spindles), baling machines, and those which, for distinction, are now termed "warp winding machines," which,

however, frequently include what might more properly be termed "spooling machines," but which are more properly confined to that class of machines which lay the thread in cross winds or reverse coils, building up a generally cylindrical package with substantially flat ends.

The reels of the present day have all the general characteristics of those made first, and while the ancillary details of the spooling mechanisms have gradually improved until a modern thread spooler possesses almost a mechanical brain, yet the same elemental devices pertain to all of the spooling structures so far as the mere deposit of thread in the building up of the cop is concerned. It is in the apparatus for balling and for cross-winding, or building up cops without the use of spools, that the greatest structural changes have taken place and that the greatest advance has been made.

While a great number of inventors have contributed to the general advance in the art, the larger portion have followed along fundamentally accepted lines, each adding his quota of improvements, but the result has been that by far the larger portion of such improvements have related to minor structural details, and a reference to comparatively few of the earlier structures is sufficient to illustrate the more prominent features of departure from the earlier existing forms.

Practically all of the improvements that have been made in these different classes of packages and machines for making the same have been embodied in letters patent, more generally in Great Britain and the United States, and a fair understanding of the development and progress in the art can well be had from an investigation of a few of the more prominent patents relating to the respective classes. In view of the fact that, so far as reels are concerned, there is no substantial difference between those of the earliest and those of the latest forms, it is not necessary for us to give this matter special consideration, but the remaining three classes are detailed below:

Balling Machines.—While many of the machines which deposit the thread or yarn upon spools, and sometimes so as to form cylindrical packages, are recognized as coming technically under the term "balling machines," we consider that properly this class of machines embodies only those where the thread or yarn is crossed at different angles and built up upon a gradually expanding core so as to form an approximately spherical package.

The general characteristic of balling machines has been an inclined spindle, and a yarn carrier rotating about the spindle in plane at an angle of the axis thereof, which axis is changed from time to time, so that the cord is carried practically in circles about a changing axis.

One of the first illustrations of such a construction is in Young's British patent 12,353, of 1849, which shows a series of inclined spindles, the cord carried by flyers and the spindles carried by a swinging frame. A similar construction is shown in later patents.

In United States patent to Billings 165,978 the parts are so driven that the inner layers of the ball are wound with considerable intervals between them, the outer layers being laid in close proximity, thus securing an elastic package.

In Mitchell's United States patent 408,842 is described a ball which is wound with a regulated proportion between the speed of the spindle and that of the guide. By this means an irregular honeycomb spherical structure is secured, and, so far as we are aware, this is the first attempt in connection with any kind of winding to secure a symmetrical disposition of the coils throughout the entire body of the package. As a result of the timing of the parts, however, the package varies in character from the centre outward.

In Mitchell's United States patent 408,842 is described a ball which is built up by first winding a short rounded body portion upon the spindle, the coils being laid in circles crosswise and gradually increasing the length and diameter of successive layers. An attempt was made in this case to secure a structure in which one layer was deposited upon and practically covered the other, but it is evident from the reading of the specification that no such result could be secured by the method described.

In Hetzel's United States patent 501,186 the cord is laid by a flyer upon a rotating spindle in circles at an angle to the spindle, first in one direction and then in another with the object of building up a nearly cylindrical ball.

Such cylindrical balls have now became known through the use of such apparatus as is described in the aforesaid patent and that of Good, 730,635, but are distinguished from warp-winding cylinders in that the cord is laid in circles including and passing around the ends of the package, especially at the surface, although there are many varieties and modifications. Practically all that is done at the present day in connection with this class of winding differs but little except in details of mechanism from the structures in use at the beginning of the last century.

There is one class of wind which differs in a degree from either the ball wind or the warp wind, and that is a wind laid by carrying the yarn in circles first in one direction and then in another, crossing the yarn upon a card or substantially flat holder. This character of winding was made by hand for many years, and was especially common in packages of different kinds made in Germany. One of the first illustrations of this mode of winding is in Spach's British patent 14,343, of 1885. The machine had a vertical rotating shaft which supported an inclined rotating spindle, with a stationary guide in a fixed position at one side. This machine is noticeable from the effort that was made to secure a particular progressive relation of movement between the rotation of the spindle carrying the card and the vertical rotating shaft carrying said spindle, with the view of attaining a somewhat symmetrical character of wind. An apparatus for

a similar character of flat wind was patented by Hargreave, in United States Letters Patent 245,373. In this a rotating spindle carried the flat card and the guide was at the end of a rod, which reciprocated in a block supported by trunnions, which also permitted the rod to vibrate so that the guide end travelled in an approximate circle, the guide being movable upon the rod so as to progressively travel from the package. The result was the cross-wound package upon a flat card similar to the Spachs' structure.

A subsequent patent to Spach, No. 15,385, of 1885, showed a similar support for a bobbin or tube upon which the flyer deposited the yarn in cross coils.

Another character of wind which was not a warp wind, and only approximately a ball wind, and intended especially for use for the bobbins of sewing machines, was quite extensively wound, beginning about 1890, at the Willimantic Linen Company's Mills in Connecticut, and which is also illustrated in British patent to Lawson, 1,003, of 1862. This wind was built up by a reciprocating guide opposite a rotating spindle and the mechanism was so timed that the thread was laid first in a ring midway between the ends of the tube upon the spindle and as the cop increased in size the width of the mass of material gradually increased until it was of the length of the finished cop, the surface longitudinally being almost semicircular, and then gradually flattened until the package finally produced was cylindrical. In this cop each coil at the surface portion extended in a circle from one corner of the cop diagonally to the opposite corner, the outer layer being at a reverse angle to the under layer.

Warp Wind.—A warp wind as applied to a cop upon a tube or quill may be said to embody generally the laying of the thread or yarn helically first in one direction and then in another through the medium of a rotating spindle or holder carrying the cop tube and a reciprocating guide.

In the earliest machines that were used for this purpose the spindle supporting the cop tube was positively driven at a uniform speed and the guide reciprocated at a uniform speed, building up what might be termed a cross-wound cop, and sometimes the guide was operated so that the cop would have substantially flat ends, or at others the extent of reciprocation of the guide would be reduced to impart conical ends to the cop, and at others the guide would be reciprocated opposite the conical base of a cop tube and gradually moved forward longitudinally so as to build up the cop lengthwise. All these different modes of operation were set forth at an early date in the Willis British patent 14,151, of 1852.

In the Smith & Rowcliff British patent 2,585, of 1861, the spindle was positively driven and the guide reciprocated, but carried a multiple of threads and the package was built up upon a spool.

In Combe's British patent 1,241, of 1867, a cross-wound cop was built up by the reciprocation of a guide opposite a rotating vertical spindle. This

guide was at the end of a pivoted arm swinging at one side of the cop, and the spindle, instead of having a given number of rotations to each reciprocation of the guide, had a varying speed, so that its rotation was diminished as the cop was built; the result of the course being that the cop varied in character from the centre to the exterior.

An illustration of common form is in Rosskothen's United States patent 400,118, which particularly describes a cop built up in the irregular cross-wind manner, the number of turns in the helix laid upon the core diminishing as the size of the cop increases.

In the first machines the cop spindles were directly and positively driven, but a friction drive was subsequently employed. As shown in Harter's British patent 6,976, of 1836, the end of the spool or spindle rests on a driving disk and is rotated thereby and this arrangement is to be found in later patents. Soon, however, it seemed to have been considered preferable to drive the package itself, instead of its spindle, thereby enabling each spindle to operate independently, the packages resting upon rotating rolls or drums and the spindles upon which they were wound sliding vertically or radially in respect to the driving shaft or drum in parallel side grooves. As early as 1770, Crawford in his British patent 974 describes a series of drum-driven bobbins on each of which the yarn is laid, all of the guides carried by a reciprocating bar. In Cheatham's British patent 596, of 1869, there is described a balling machine, but it also shows a guide reciprocated by a heart cam, and a spindle driven by a drum on which the spindle lies building up an open cross-wind package with flat ends.

United States patent to Hanson, No. 353,745, subsequently issued, shows substantially the same mode of winding, the spindle being carried by a frame pivoted at one side, so that the spindle could rest upon the face of the driving drum.

United States patent to Ashworth, 285,203, also shows a common character of apparatus extensively used where the spindles are guided between vertical guides so as to rest directly on the driving shaft, and the guides opposite the several spindles are carried by a reciprocating bar, producing a cross-wind.

We might refer to various other drum-driven apparatus, as for instance Hill & Brown's in British patent 5,532, of 1883; Knowles' British patent 10,065, of 1888; and Foster's United States patent 459,039.

The cops thus built have not always been cylindrical, for by the use of a conical holder resting upon a drum and adapted to swing away from the latter a conical cross-wound cop may be built up, an illustration of this being in Broadbent's United States patent 493,970.

A somewhat peculiar package and apparatus is set forth in Miller's United States patent 443,103, where there is a rotating spindle and a reciprocating guide, which, however, has also a progressive movement longitudinally of the spindle and gradual increases in extent of reciproca-

tion, the result being that the cord is wound between heads upon the spindle in a series of conical spool-wound layers, gradually increasing in length until the diameter of the cop is attained, and then progressively laid of the same length until the requisite length is attained, after which the length of the layers is gradually reduced, so that the final result is a cylindrical spool-wound package in which the layers coincide with cones instead of cylinders.

The above epitome is far from being exhaustive, or even full, and only in a fragmentary way sets forth some of the main differences between modes of winding and machines prior to the year 1900.

About that date Mr. Simon W. Wardwell produced a package and used a method of operation and apparatus involving practically a new principle of construction in the building up of cops. This principle consisted in a predetermined fixing of the position of every coil to be laid in the cop, and in laying each coil positively and with certainty in its place, and forming a cop consisting of a succession of cylindrical layers, each layer consisting of crossed helices with the coils side by side and the same in number in each layer. In the prior art practically all of the cops or packages had been built up either from a central short core, gradually increasing in length as the cop increased in size, or from successive cross coils of uniform length laid indiscriminately, sometimes more regularly than at others, with the disadvantage that the pressure of the outer coils resulted in indenting and creasing the yarn; the packages were lacking in solidity and uniformitiy; the yarn would not deliver uniformly, but one coil would catch upon another as the yarn was drawn off, and with other defects well known to those skilled in the art, and the Wardwell wind was soon recognized as embodying very substantial and radical improvements over all that preceded it. In the Wardwell cop the yarn or thread is laid to all intents and purposes as compactly as in a spool wind, but without the necessity of using heads upon the bobbins. Each layer is so smooth and solid that there is no indent of the yarn or thread of the subsequent layers, and the delivery, which can take place from the end of the cop, results without any retardation or catch of one coil upon another, and is as free in this respect in the first layer inside the cop as it is in the outer layer. The original character of the Wardwell cop can be understood from the claim which was allowed by the Patent Office upon a reissue of the Wardwell patent (necessitated from a too vague description in the original patent) which was granted only after a most searching investigation, and after the production by parties in litigation of everything that could be set up against the Wardwell method of winding. The said claim is as follows:

"The within described systematic method of cop-building, consisting, first, in definitely placing thread upon a holder in a helix extending from end to end, in the position on said holder it is to occupy in the

finished cop; second, in bending the thread at each end to form an abrupt bend which occupies a position circumferentially beyond that at the opposite end; third, returning the thread in a reverse helix to the opposite end and crossing and tying down the thread of the first helix at one or more points between the ends of the cop; fourth, carrying the thread, at each end, with an abrupt bend over the portion previously laid at a point circumferentially different from that at which the helix started at that end; fifth, continuing these operations to lay the helices in contact with each other progressively on the core until the core is uniformly covered, forming a single layer of two thicknesses of thread consisting of crossed helices; sixth, building successive layers upon the first, all having the same number of turns in the helices as the first, thereby forming a cop of the desired length and diameter, consisting of superposed similar layers of thread, each layer uniformly covering the layer below, and each composed of series of superposed crossed helices, each extending from end to end of the cop, the helices successively bent back at the ends at different points circumferentially, substantially as described."

The Wardwell fundamental method of winding has been embodied not only in cylindrical cops but in tapering cops and in cops of the character used for shuttles of looms, where the coils are conical and lay one forward of the other.

The various forms and styles of cops in which the invention of Mr. Wardwell has been embodied have necessitated very many modifications of the forms and arrangements of his winding apparatus which has been brought to a most perfected state and which constitute the subjects of a large number of Letters Patents.

The essential characteristic, however, of all of the apparatus is that in addition to the reciprocating guide eye, which is always maintained in contact with the point where the thread is to be laid on the rotating spindle or mass, means are provided whereby there is added to the movements requisite to laying a helix of any determined number of coils such a precise, definite and calculated additional movement as will insure that each coil shall be laid in place parallel and alongside of an adjacent coil. All parts of the apparatus work with the utmost precision. There is no factor of chance of accident in the lay of the coils of thread or yarn, which cannot be said of any other system of winding except in the ordinary spooling, and each rotation of the thread or yarn is laid positively and fixidly in the groove it is to occupy in the completed cop.

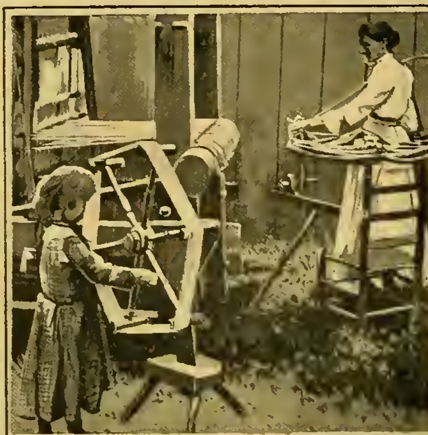
Spool Machines.—These machines may be placed in two groups: The first including the various types of machines by which the yarn is wound in substantially concentric coils on spools having flanges at right angle with the cylinders.

In this type of machine, which is in general use in cotton mills for transfer purposes, the yarn guide moves slowly from end to end of the spool.

PLATE VI—Winding

1

2



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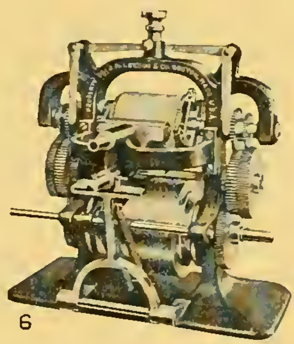

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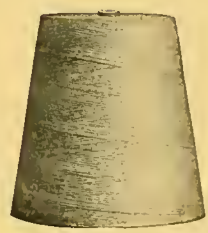

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1. Indian Winding.
2. Primitive Method of Winding.
3. Primary Winding Illustrating the "Universal" Principle.
4. Primary Winding Showing Accuracy of Adjustment.
5. Multiple Yarn Winding for Wire Insulating.
6. First Universal Machine.
7. Conical Package of Knitting Yarn.
8. Twine Package for Shipment.
9. Quill for Narrow Loom Shuttle.
10. Bobbin for Broad Loom Shuttle.

so timed with reference to the rotation of the spool that the coils of yarn lie approximately side by side, the flanges being relied upon to prevent them from falling over the end. This type of machine is very simple in construction and, although manufactured in many forms of structure, has not been improved radically in principle since its earliest introduction into cotton mills.

When adapted for winding from skeins, the spool is generally driven inductively so that any excess pull on the yarn from tangling of skein will stop the rotation of the spool, and thus avoid breakage of the yarn.

In winding several yarns on one spool, to be used as supply for a twister, each yarn passes through its individual guide to the spool with a drop wire, which stops the spindle when the end of the yarn runs out or when the yarn breaks.

The Boyd spooler was the earliest adaptation for this purpose, and in this structure the cylinder of the spool rested upon the rotation drum extending between the flanges; this system of friction driving giving a regular and constant speed to the yarn when being drawn on to the spool as the rotation of the spool decreased in speed as the mass of yarn was built upon it. Several other machines have since been built upon this principle which are in general use.

The Combe's Patent was probably the first attempt made to secure a self-supporting package in the form of a cylinder with flat ends. the change from the previous construction being that of reducing the rotation of the driven spindle in proportion to the growth of the cop. The transition from this structure to that of the friction drum was natural. The practical introduction of what is termed "drum-winding" dates from about this time, and was embodied in a variety of machines, varying somewhat in structure, but all built upon the same principle; that is, the rotation of a drum upon which the cop rested, the drum and thread guide being driven at a regular speed the cop rotating slower and slower as it increased in diameter, constantly changing the ratio of coils on the surface. At certain intervals, when the ratio of rotation of the cop to the guide was regular, such as two, three or four to one, there would appear on the surface of the cop crossings of the yarn, which, as they approached the exact ratio, would lie closer and closer, and having passed the given point would expand, thus giving the appearance termed ribbon wind, the cop at these points being packed closer, and the friction being applied in contact with the ribbon instead of being distributed over the whole surface of the cop would, in some classes of material, produce injurious results. In later types of friction or drum machines special mechanism has been introduced to overcome this defect, and by constantly changing the ratio produced a more uniform distribution of the coils.

Previous to Hill & Brown's Patent the friction or drum type of machine was constructed with the thread guide some distance from the sur-

face of the cop and reciprocated by special mechanism. The Hill & Brown invention departed from this structure and introduced an angular slot in the drum, extending from N to M, through which the yarn was threaded, thus operating as a cam to force the yarn from end to end of the traverse at each evolution of the drum. Machines constructed upon this principle have been widely used in mill practice, as a much higher yarn speed was secured than by structures using the reciprocating guide. Their use has been largely confined to Great Britain and the continent of Europe, as the mill requirements in the United States are such that the machines have not met with a ready introduction here.

THE HISTORY OF WEAVING.

The art by which threads or yarns of any substance are interlaced so as to form a continuous web is perhaps the most ancient of the manufacturing arts, since clothing must always have been a primal necessity to man. A knowledge of weaving seems to have been inherent to a slight extent in all races, and to have developed as they emerged from savagery, beginning with the plaiting of rushes or other fibrous materials into mats and aprons, followed by rudely woven cloths. A piece of flaxen cloth, plaited rather than woven, was found in the lake dwellings of Switzerland, which is supposed to have been made by prehistoric man in the Stone Age; and in various ethnographical museums may be found specimens of the handiwork of peoples who lived in those portions of the globe which were unexplored a few centuries ago, and which were quite unknown to the ancients. Nearly all these races when first visited by civilized man had more or less knowledge of weaving and spinning, mat-making, plaiting and net-making. For any advance in these arts beyond the most rudimentary knowledge, Western peoples are wholly indebted to the ancient civilizations of the East, where it had passed to a rare excellence in the most primitive times, thousands of years before the inhabitants of Europe and of Britain had so far emerged from savagery as to clothe themselves in the skins of wild animals, or to dye and stain their bodies with the juices of plants, in default of other covering.

We find allusions to the loom and its product in the most hoary records of antiquity. In the early part of the nineteenth century certain inscriptions were discovered near Adon, on the coast of Hadramant (Arabia) which the scientists declare take us back to the time of Jacob, about five hundred years after the flood, and about 2,655 years B. C. These records are said to restore to the world its earliest written language, and were first deciphered by the Rev. C. Forster, of Great Britain. In the longest inscription, which consists of ten lines engraved on a smooth rock, forming one side of the terrace at Hisn Ghorab, is this sentence: "We walked with slow, proud gait, in needle-worked, many-colored silk vestments, in whole silks, in grass-green chequered, and damask robes—woven on the loom."

The honor of inventing the arts of weaving and spinning was ascribed by the ancients to divers personages who existed in the age of myth and fable, which would seem to indicate that from immemorial times they had been practised by the women of the different nations. Thus the Egyptians credit Isis; the Assyrians, Semiramis, their queen; the Greeks, Minerva;

the Mohammedans, a son of Japhet; the Chinese, their Emperor Yao, and the Peruvians, Mama Oella, wife of Manco Capac. Tradition also ascribes it to Naamah, sister of Tubal-Cain. The simplest and earliest form of weaving was thus accomplished: A number of parallel threads, called the warp, were attached to a horizontal beam and drawn taut by weights attached to their lower ends. In the early Greek loom, each warp thread had a separate weight. The threads of the warp were interlaced at right angles to those of the weft, and the combination of the two formed the web. The threads of the weft were wound round a bobbin made to revolve inside a hollow boat-shaped case of wood, pointed at both ends to facilitate its easy passage between the threads of the warp, the thread passing out through a hole in the side of this primitive shuttle; a reed divided the warp into two sets called leaves, the first one and then the other of the leaves were pulled forward and a plain, interlaced web was woven. Later, two shuttles were introduced, containing threads of different color, and striped or checked cloth was produced. In wall paintings brought from Thebes, which date from 1600 B. C., upright looms, similar to the one just described, are depicted as they are in earlier ones from Beni Hassan. A strikingly similar loom is represented on a Greek vase of the fifth century B. C., with a picture of Penelope and Telemachus. The weights used on these looms in ancient Greece consisted of clay whorls, or cones, pierced and decorated with simple paintings. Dr. Schliemann found 22,000 of these cones on the plains of Troy alone. In Scandinavian countries the use of weights continued up to modern times.

The Indian loom, which dates from prehistoric times and which is still in use in most parts of India, consists of two bamboo rollers, one for the warp and the other for the web, and a pair of geer. The shuttle performs the double office of shuttle and batten, and for this purpose is made like a large netting needle, and of a length somewhat exceeding the breadth of the piece. (In variants of this loom, the shuttle is sometimes of a small size and is thrown.) This apparatus the weaver carries to a tree, under which he digs a hole large enough to contain his legs and the lower part of the geer. He then stretches his warp by fastening his bamboo rollers at a due distance from each other on the turf by wooden pins. The balances of the geer he fastens to some convenient branch of the tree over his head: two loops underneath the gear, in which he inserts his great toes, serve instead of treadles; and his long shuttle, which also performs the office of batten, draws the weft through the warp and afterwards strikes it up close to the web." (See Plate 7.) The method of weaving figured Indian muslins is thus described in a work published for private circulation in the nineteenth century.

"Two weavers sit at the loom. They place the pattern drawn upon paper, below the warp, and range along the track of the woof a number of cut threads equal to the flowers or parts of the design intended to be made,

and then with two fine-pointed bamboo sticks they draw each of these threads between as many threads of the warp as may be equal to the width of the figure which is to be formed. When all the threads have been brought between the warp, they are drawn close by a stroke of the lay. The shuttle is then passed by one of the weavers through the shed, and the weft having been driven home, it is returned by the other weaver. The weavers resume their work with the bamboo sticks, and repeat the operation with the lay and shuttle in the manner above described, observing each time to pass the flower threads between a greater or less number of the threads of the warp, in proportion to the size of the design to be formed." In this simple manner and with the simplest of weaving apparatus, the delicate, as well as the elaborate productions of India, have been woven from time immemorial. "A specimen of Mulmul khas (muslin made for the king), says another writer, "measuring ten yards by one yard, contained 1,800 or 1,900 threads in the warp. It weighed three ounces, two dwt. fourteen grains troy. It is so fine as to pass through the smallest ring. Price, 100 rupees, or $50. Another specimen, as worn by native dancers and singers, measuring twenty yards by one yard, had 1,000 threads in the warp, and weighed eight and one-half ounces."

On the American continent, the Peruvians as well as the Aztecs and the Mexicans of ancient times possessed from prehistoric times a knowledge of the art of weaving. At Tarapaca, in Peru, in 1874, a mummy was dug up, and with it was cotton twine and a woven bag. These were found beneath the volcanic formation called Chuco, which is itself of vast antiquity. Under the Incas, the Peruvians made woven goods from the fibre of the maguey, as well as woolen cloth for their own use, and vicuna cloth for the Inca. Vigona wool was wrought into shawls, robes and other articles of dress for the monarch, and into carpets, coverlets and hangings for the imperial palaces and the temples. The cloth was finished on both sides alike; the delicacy of the texture was such as to give it the lustre of silk. The Peruvians produced also an article of great strength and durability by mixing the hair of animals with wool." (Prescott.) The Chileans manufactured woolen cloth for garments, using the spindle, distaff and loom, and the women were apt at the art of embroidering in 1535, when Almagro invaded Chili. The Aztecs, or Ancient Mexicans, were skilled in weaving cotton into webs of every degree of fineness, and made a peculiar cloth, both warm and beautiful, by weaving into their cotton cloth the hair of rabbits and other animals.

An instance of the universal knowledge of weaving among all peoples is given by a writer who accompanied the troops in the Ashantee War. He says: "The Fantee weaver uses a loom of a very primitive construction, but is marvellously quick at his work, throwing the shuttle from side to side with his hands, and working the treadles with his toes. The thread used is extremely fine, and of the brightest colors, but the pattern is not

of a very elaborate nature. The material is very dear, being a dollar a yard, at least double the price of English fabric, but is very strong and lasts much longer."

The materials used in weaving comprise: first, animal fibres: the transitition from the wearing of the skins of animals to weaving their sheared fleeces seems a natural one, and as the wealth of nomadic peoples consisted largely of their flocks and herds, there was naturally no lack of material. Among these animal fibres are sheeps' wool, camels' hair, goats' hair, beavers' wool and silk, which is first mentioned by Aristotle, and the fibres of the pinna, a shell-fish found near the shore of South Italy, Sicily, Corsica and Sardinia. This curious bivalve fastens itself to the sand by a tuft of silken fibres, and these fibres were woven by the natives of Tarentum into stockings and gloves, which were said to preserve the wearers from the effects of damp.

Then come the vegetable fibres, flax, cotton, maguey, sisal hemp and the fibrous portions of various plants of the agave family.

The minerals follow, gold being by far the most largely used from the very earliest times to the middle ages, being particularly characteristic of Oriental customs. Silver also was used, though to a more limited extent. There are frequent allusions to the use of gold in Holy Writ: Moses describes the method by which it was prepared for the loom: "They did beat the gold into thin plates, and cut it into wires to work it in the blue, and in the purple, and in the scarlet, and in the fine linen, with cunning work" (Exodus xxxix. 3). A modern writer affirms that he saw in Rome a sample of cloth in which the wire was as fine as No. 205 (this is an English number and may differ from the American modern way of numbering) of the cotton yarn of to-day.

Virgil writes that Dido the Sidonian, in Trojan times, wove a garment with gold, and also that one was woven by Andromache. Herodotus mentions a tunic made in Greece as being "all made of silver and wonderful in its texture." The Persians in very ancient times made shawls of purple interwoven with gold. A very costly cloth of gold was called by the Romans "attalica," after Attalus. The Cæsar Cestus, who died about the middle of the first century before Christ, left orders in his will that his body should be wrapped in certain pieces of attalica; but as this was forbidden by a sumptuary law, his heirs sold the attalica, and with the proceeds had two colossal bronze statues made, which were set outside the tomb, C. Cestus being buried in the exisiting pyramid in Rome. The feet of one of these statues have been found, with a pedestal on which are inscribed the facts above related; the size of the statue attests that the attalica must have been worth a very large sum. The Chinese also used gold in their silken materials, which in mediæval times were imported into the West of Europe, and sometimes used in churches, etc. In classical times, attalica and other gold stuffs were made of solid gold wire, made

as Moses describes, and masses of this fine gold wire have from time to time been found in the tombs of Egypt, Greece and Etruria, the metal having lasted long after the rest of the materials had perished beyond a trace. The grave of the wife of Honorius was opened in 1544, and thirty-six pounds of gold thread were taken out of it and melted.

Another mineral used by the ancients in the loom was asbestos, which is mentioned by Strabo as being used to make the funeral shirts of kings. A piece of asbestine cloth was found in a tomb at Puzzuolo in 1633, and it is preserved in the Barberini Gallery. Another piece was found in a marble sarcophagus in a vineyard a mile without the Porta Major, at Rome. It was about five feet wide and six and one-half feet long, and contained the skull and other burnt bones of a human body. It is preserved in the Vatican Library, and is thus described by one who saw it: "It is coarsely spun, but as soft and pliant as silk." In Cyprus and Arabia asbestos was spun and woven into socks and stockings and underdrawers.

Allusions to the loom and its products occur frequently in Holy Writ: Pharoah arrayed Joseph in "vestures of fine linen," and we must not forget that Joseph, when sold by his brothers, wore a "coat of many colors," which had awakened their envy. The directions for the furnishings and hangings of the Tabernacle show that the Jews had acquired the very highest degree of excellence in the arts of weaving, embroidering and coloring. The figures of the Cherubim must have been woven, since in curtains of the width described it would have taken an age to embroider them by hand. They manufactured to a great extent fabrics of blue, purple, fine linen and goats' hair (Exodus 36: 1, 2), and the allusions to lace (Exodus 28: 37 and 39: 21, 31) show that they were skilled in the art of lace-making. Some of this knowledge was doubtless acquired during their sojourn in Egypt. We learn, however, from the Old Testament that the Israelites from the dawnings of history had been proficient in the inventive arts and skilled in mechanical occupations; they "were filled with wisdom of heart to work all manner of work of the engraver, and of the cunning workman, and of the embroiderer in blue, and in purple, in scarlet, and in fine linen, and of the weaver; even of them that do any work, and of those that devise cunning work" (Exodus 35: 35).

Although Herodotus visited Egypt about 450 B. C., and describes much of the manner of life of the Egyptians at home and abroad, he singularly enough makes no further allusion to the loom than this: "Other nations in weaving shoot the woof above; the Egyptians, beneath."

The ancient Egyptians were also skilled in the production of lace and net, the designs and figures of which were very elaborate. The prophet, in his denunciations of the Egyptians, particularly threatens the flax and lace manufacturers: "Moreover, they that work in fine flax and they that weave networks shall be confounded" (Isaiah 19: 9).

Some of the cloths wound around mummies were woven with stripes of contrasting colors, as blue and fawn. A scarf is in existence bordered with seven stripes of blue, the broadest at the edge of the selvage being half an inch wide, followed by five very narrow ones and terminated by one an eighth of an inch broad.

The operations of the Egyptians were not confined to flax, however; they wove wool, cotton and silk, and their figured materials were very beautiful and eminently artistic. Specimens of the linen woven by the ancient Egyptiains are preserved in the British and other national museums, some of these being nearly four thousand years old. Several of those in the British Museum are extremely fine and have the appearance of being woven from thread about 100 hanks to the pound, with 140 threads to the inch in the warp and 64 in the woof, this peculiarity of weave being noted in all the specimens of mummy cloth.

Insignificant indeed are these examples when compared with those we find noted by the oldest historians or mentioned in Holy Writ, almost incredible stories being related in regard to the fineness of their linen. Herodotus mentions a pallium sent by King Amasis II (572-528 B. C.) to the Spartans which was made of yarn containing no less than 360 threads; figures were woven on this garment, partly of cotton and partly of gold thread; the same historian mentions a wonderful pallium sent by the same king to the Shrine of Athene at Lindus. The Egyptians also wove carpets quite like the modern Brussels and tapestry. Toward the close of the nineteenth century, a large quantity of woven materials were found in the tombs at Panapolis in Middle Egypt, which apparently dated from the fourth to the seventh century A. D. In the earliest of these, the designs were purely classical, while the later ones appear to be coptic vestments and are decorated with rude figures of Saint George and other Oriental Saints. The figure drawing of these fabrics is rude, but the decorative value is very great; they are specimens of true tapestry weaving, the weft pattern being in brilliantly colored wools on a flaxen warp.

The Phœnicians were renowned for their skill in the manufacture of textiles. Especially were they famed for their purple linen made at Tyre and Sidon. Babylon was celebrated for its shawls, and Carthage, Sardis, Miletus and Alexandria were all seats of textile manufacture in the time of Herodotus.

Assyria, too, was far advanced in the textile arts; for though no specimens of the productions of Assyrian looms remain, some idea of their work may be gathered from the sculptured wall-reliefs from Nineveh, which are now in the British Museum. The garments of Asur-banipal are covered with delicate geometrical patterns with highly decorative borders of lotus and other flowers. On the enamelled wall tiles from the palace of Rameses II, at Tel-al-Yahudiga (fourteenth century B. C.), still more

magnificent stuffs are represented as being worn by Assyrian captives, the woven patterns being minutely reproduced in their different colors, and the Assyrian design of the sacred tree between two guardian beasts is represented on the most minute scale with great fidelity.

The textiles wrought in Spain under the Mohammedans though bearing real or imitation Arabic characters and other sign marks of Saracenic influence, had yet some distinctive features of their own. The designs were almost always some combination of geometrical lines, reticulations, conventional flowers, the crescent moon being infrequently figured. The colors were usually a fine crimson or a deep blue with fine-toned yellow as a ground. The gold used in their textiles was parchment cut into thin strips after being gilded with gold leaf.

Free from Saracenic control, the Christian Spanish weavers covered their cloth with birds, beasts and flowers; but the fine crimson coloring was still a distinctive feature. Spanish velvets were chiefly made in Andalusia; they were remarkably fine and distinguished both for their deep, soft pile and their glowing ruby tones.

The history of the Sicilian loom is most interesting and varied. The Mohammedans imparted to the people of Sicily the art of manufacturing garments from cotton and how to rear the silkworm and spin its silk. Sicilian designs show also the Saracenic influence; from the Mussulmans, they must have obtained their knowledge of the fauna of the vast continent of Africa, the giraffes, antelopes, gazelles and lions, the parrots of India and the cheetahs of Asia; thus the first textile period of Sicily shows not only beasts and birds, but also Arabic words of greeting mingled with the flowers and foliage. As will be shown later on, when the Moslems had been driven out by the Normans, many of their weavers must have remained in Palermo, for their teachings in design and weaving were followed for several centuries afterward.

Our knowledge of early Greek textiles is largely dependent on the descriptions given by various classical authors, though there are a few remaining specimens, one of which, a remarkable specimen of tapestry from a tomb in the Crimea, is alleged on the highest authority to date from the fourth century before Christ. The poems of Homer resound with descriptions of woven stuffs of the most magnificent description, both as to material and design, used both for dresses and for hangings. In the Odyssy (225-235), he describes a cloth of purple wool with a hunting scene in gold thread woven by Penelope for Ulysses. Many of the Greek vases have representatives of rich woven dresses. One of these, an amphora in the Vatican, shows Achilles and Ajax engaged in a game resembling draughts. This vase dates from 460 B. C., and a rather later example in the British Museum shows a splendid figure of Demeter clad in a pallium covered with figures of chariots and winged horses. In later times, we read of magnificent peploi woven to cover or shade the

statues of the deities at the famous shrines of Delphi, Olympia and at Athens and the treasuries of most Greek temples contained immense stores of rich woven stuffs. Euripides describes with glowing commendation a peplos belonging to the temple of Apollo at Delphi, on which was represented the firmament of heaven, with Apollo Helios in his chariot, surrounded by the chief stars and constellations. Weaving among the early Greeks and also the Romans was a distinct trade, carried on in towns specially devoted to manufacture, yet every considerable domestic establishment, especially in the country, contained a loom, together with all other necessary apparatus for the production of woolen cloth. When the farm or estate was sufficiently extensive, a portion of the house or palace, called the "textrinum," was devoted to the purpose, and the work there was carried on by female slaves under the superintendence of the mistress of the house and her daughters.

The Romans, under the later Republic and under the Empire, possessed immense stores of the most magnificent textiles of every description. Among those was the splendid collection of tapestry which, as well as the other art treasures owned by that monarch, Rome inherited from Attalus II of Perganum (second century B. C.). From the same monarch the very costly cloth of gold called "attalica" received its name. Mettellus Scipio bought hangings from Babylon for which he paid 800,000 sesterces, and similar pieces were bought by Nero for four millions of sesterces, (about $16,800). Virgil tells of woven tapestries used in the theatres on which were depicted the figures of Britons; and many others representing classical themes are mentioned by contemporary writers.

Although by many it has been supposed that the ancient Britons had no knowledge of weaving, specimens of coarse cloth, resembling baize, have been found in ancient British barrows, and Boadicea is said to have worn under her mantle of fur a motley tunic of many colors, which was probably of native manufacture. Still the knowledge was primitive and Britain was indebted to the Roman conquest for her early progress in textile manufacture. The Romans under Claudius (10 B. C.—54 A. D.) established factories at Winchester and other places for the making of cloth for their armies and of sailcloth for their navy, and Britons were presumably instructed by them in the art and employed in these factories, for it had advanced to considerable importance at the Anglo-Saxon period. Spinning was the occupation of the Anglo-Saxon ladies, and after the cloth was woven they embroidered it with great skill, using colored silk and gold and silver threads. Their work was celebrated on the continent and was called English work, as in previous times a similar fabric was styled Phrygian. King Edward the Elder sent his "son to scole and his daughter to work wole," that is, to learn to spin and perhaps weave wool. The Anglo-Norman ladies were also proficient in what were then considered domestic arts; and tapestry, which adorned the walls of baronial castles,

was, in all probability, made by the ladies of the household. William of Malmesbury says: "The shuttle is not filled with purple only, but with various colors, moved here and there among the thick-spreading threads, and by the embroiderer's art they adorn all the woven work with various groups of figures." An ornamental cloth called baudekin was made, which for a long time was highly esteemed. A few specimens of Anglo-Saxon and Anglo-Norman weaving and embroidery still exist; of the latter, perhaps the best known is the famous Bayeux tapestry, which until lately was believed to have been worked at least in part by Matilda.

Much cloth of an ordinary kind for the habiting of the people must have been made during this period, for long before the conquest the weavers of London had formed a corporation or guild, the first of its kind in England, and shortly after guilds were also established at Winchester and Salisbury. These guilds had no right of incorporation and paid fines or taxes to the king for the privilege of making cloth.

At the inception of the Anglo-Norman period, the craft of weaving in England received a stimulus from an unexpected quarter.

The woolen manufacturers of Flanders are said to have been established about the middle of the tenth century during the years 958 and 960, and so noted did they become for their skill in cloth making, that one, writing of them, says: "It seemed in them to be almost a gift or instinct in nature." To these able craftsmen England is greatly indebted for her knowledge of the art of weaving. During the reign of William the Conqueror (1027-1066) an inundation in Flanders drove numbers of these artisans to seek refuge in England under the protection of William, who had married their countrywoman, Matilda of Flanders. He settled them at Carlisle, but the ill will of their neighbors involved them in so many broils that Henry I removed them to Ras, now a part of Pembroke, where their posterity can be recognized to this day. The cloth industry appears to have been exceedingly prosperous in the reign of Henry I. One of the foremost of the manufacturers was Thomas Cole, the rich clothier of Reading, "whose wains filled with cloth crowded the highway between that town and London." It is recorded that Henry gratified Cole by fixing the set measure of a yard, his own arm being the standard thereof.

But wool was not the only material woven by the looms of that time. The linen manufacture was well established in Norfolk in 1307. Aylesha, in that county, was particularly noted for its flaxen fabrics, and "the Aylesham Linens," "Aylesham Weaves" and the "fine cloth of Aylesham" are frequently mentioned in old records.

It was in the reign of Edward III that the woolen manufacture became firmly established in England. To foster it the king forbade the exportation of wool and the importation of foreign cloth, and proclaimed "that all cloth-workers of whatsoever country they be, which will come into England, Ireland, Wales and Scotland, within the king's power, shall

come safely and surely and shall be in the king's protection to dwell in the same lands, dwelling where they will, and exercise their trade;" "by which," adds the historian, "many were drawn, so was it the principal cause of advancing that most beneficial trade." The king became surety for the immigrants until such time as they were established in their occupation. Many Walloons availed themselves of this invitation, to the great betterment of the industry. But all were not of the king's mind, and the foreigners met with hostility. In 1342, the magistrates of Bristol persecuted Thomas Blanket and some other citizens who had set up looms in their own houses and hired Flemish weavers to make woolen cloth. Thomas Blanket, whose name was applied to the article made by him, appealed to the king, who wrote to the corporation: "Considering that the manufactures may turn out to the great advantage of us and all the people of our kingdom, you (the mayor) are to permit the machines to be erected in their houses at their choice, without making on that account any reproach, hindrance or undue exaction." The benefits conferred upon the country by Edward were long remembered. When once the great value of the woolen manufacture became known and understood, England became very jealous of anything that might be detrimental to its progress, and laws were frequently passed preventing the exportation of wool. According to Fuller's Church History, the different branches of the manufacture settled at the following places:

Berkshire, cloth; Devonshire, kersey; Essex, Colchester sayes and serges; Gloucestershire, cloth; Hampshire, cloth; Kent, Kentish broadcloths; Lancashire, Manchester cotton; Norfolk, Norwich fustians; Somersetshire, Taunton serges; Suffolk, Sudbury bayes; Sussex, cloth; Wales, Welsh friezes; Westmoreland, Kendal cloth; Worcester, cloth; Yorkshire, Halifax cloth.

Many of the manufacturers became quite renowned in their day and their memories still live. The encouragement of Edward III may be regarded as the first important step taken for the permanent establishment of the manufacture of textiles in England. In the reign of Richard II (1379) the foreign workmen had become so numerous in England that places were set apart for their meetings, and the king, who delighted in the rich products of their looms, had a coat of gold interwoven with precious stones. While the English were laboriously acquiring their fundamental knowledge of the art of weaving, in the countries of Europe and Asia was transpiring a brilliant era of artistic achievement in textile art, of which it is proper here to give some brief account. The Moslem influence predominated during the inception of this era, which was followed by a decline of artistic weaving and the growth of the modern system of manufacture.

Byzantium from the sixth to the thirteenth century was the capital of all the industrial arts, and her influence on art during that period is particularly obvious in textile manufactures. By her the arts of ancient

Greece and Rome were fused and mingled with the artistic skill of Egypt, Assyria, Persia and of Asia Minor. The introduction of silk into Europe in the reign of Justinian, and the enduring nature of that material, has afforded us many specimens of the skill of the weaver of the times. In the tombs of Charlemagne and other kings silken stuffs were found which showed a certain class of designs much used in Byzantium. In the time of Justinian, some of these designs were of a composite character, mingling the figure subjects of Rome with the stronger decorative beauty of the East. Chariot races in the circus, consuls and emperors enthroned in state, gladiatorial fights with lions, and other classical subjects occur, arranged in medallions or wreaths, set in close rows so as to fill up the ground. Again, mixed with these classical scenes, are designs of purely Assyrian origin, such as the sacred tree between two guardian beasts, closely resembling the designs of 2000 B. C. The production of these rich fabrics was not confined to Byzantium, but was carried on in many of the cities of Greece; notably, in Corinth, Athens and Thebes, which were especially famed for their silk textiles.

From the sixth to the twelfth century Persia also, as well as Syria, produced woven stuffs of a most costly and magnificent description, masterpieces of textile design. From the eighth to the tenth century, names of the Caliphs and Arabic sentences from the Koran were introduced freely with the most artistic effects.

And now followed Sicily's second period. In the twelfth century an impetus was imparted to the industry in Sicily, which legend ascribes to Roger of Sicily, who made a raid on the shores of Attica, took Athens, Corinth and Thebes, and carried a number of the most skilled weavers of those cities to Palermo, where he enabled them to found the royal factory for silk weaving and which flourished for about two centuries. A large number of examples of the beautiful fabrics then produced in Sicily still exist, masterpieces of the textile art. One of the earliest of these is a piece of silk stuff in which the body of Saint Cuthbert at Durham was wrapped when his relics were translated in 1104; Western and Oriental designs are mingled in the figures woven upon it; birds and conventional ornaments of purely Eastern style with designs taken from the late Roman mosaics. This specimen was found on the opening of Saint Cuthbert's grave in 1827, and is preserved in the library of Durham Cathedral. The Sicilian silks of the twelfth to the fourteenth century were largely used for ecclesiastical purposes. Designs were sometimes introduced into these fabrics, such as the Assyrian sacred tree and sham Arabic letters, which seem to indicate a desire that they should pass for the genuine product of Saracenic looms. But these masterpieces of textile art have never since been rivalled either in richness of coloring or beauty of design, which were further enriched by the skillful application of gold thread.

Sicily's third is quite her own peculiar style. At the close of the

thirteenth and the beginning of the fourteenth century, she struck into a hitherto unknown path for design, and added to the Eastern elements the emblem of Christianity, the cross in various forms, sometimes in the shape of four V's so placed as to form the symbol. Her weavers partly discarded the fauna of the East and wove odd compounds, such as an animal half elephant, half griffin, winged lions, floriated crosses and harts and demidogs with very large wings and extremely long manes floating behind them, and they drew the swan in graceful lines. The Sicilians evinced in their fabrics their love for certain plants and flowers. The curled parsley leaf in its natural green was a favorite design, as well as the graceful leaves and tendrils of the grapevine.

In this period also the Sicilians were wont to introduce heraldic devices, such as wyverns, eagles, lions rampant, and griffins, and another peculiarity was the use of two dominating colors, murrey for the ground and green for the pattern, but, alas, this was also a period of deterioration for their bold-spirited designs were too often thrown away upon stuffs of a very inferior quality, in which the gold, if not base, was scanty, while the silk was sure to be mingled with cotton. The looms of Lucca, Florence, Genoa, Venice and Milan all won repute and acquired a good trade for their velvets, their figured silken textiles and their tissues of gold and silver; yet there was a provincial style in the fabrics of these states, which told from whence each piece had come. The cloths of gold and silver woven in Lucca were in great request during the fourteenth century, especially in England for ecclesiastical purposes. Exeter and York cathedrals in particular possessed fine specimens of this cloth among its vestments. Lucca was probably among the first places to weave velvet. Genoa, so celebrated for her velvets, must have early encouraged the silk industry; for a description of the earliest pieces of Genoese silk known are to be found in the inventory of the costly vestments, belonging to Saint Paul's Cathedral in 1295; from which it is inferred that the Genoese cloths must have resembled those of Lucca and of Sicily. Genoa is celebrated for her rich velvets, both plain and artistic. Some of the latter were raised or cut, the design showing in a pile standing well up in a plain silk background; others had a velvet ground with the pattern raised in a double pile, velvet upon velvet.

Venice was more original in her choice of designs and did not, like her sister cities, follow to any extent the Oriental patterns of beasts and birds. She wrought for church use square webs of crimson ground on which she figured in gold or in yellow silk subjects taken from the New Testament or the persons of saints or angels. Some very beautiful specimens of this Venetian web have as subjects the coronation of the Virgin, the Resurrection of the Lord, etc.; these designs bear so remarkable a likeness to the woodcuts done in Venice in the fifteenth century for religious books that "one is led to think that the men who cut the blocks for the

printers also worked for the weavers of Venice and sketched out the drawings for their looms." (Daniel Rock, D. D.) In the fifteenth century Venice produced good damask, usually decorated with historical designs; there is also little doubt that she too produced velvets like those mentioned above. She was celebrated for her lace and Venetian linens.

The weavers of Florence held foremost rank among the weavers of Northern Italy in the fourteenth century. Her diapers, some of which are in the South Kensington Museum amply attest her skill. Ecclesiastical webs woven in Venice display great taste in design and wonderful power in gearing the loom. But of her velvets, Venice had unquestionable reason to be proud. Henry VII bequeathed to Westminster Abbey a suit of vestments "to be made at Florence in Italy."

Milan, though nowadays famed for her beautiful silken fabrics of all sorts, was not in mediæval times so famous for the productions of her looms as for her armour; still, during the fifteenth century, rich-cut velvets were made there, specimens of which are still in existence; she wove also laces of the open-tinsel kind for liturgical as well as secular purposes.

In the fabrics of the loom gold was used very effectively and liberally throughout the middle ages, cloth of gold being employed for ecclesiastical and royal purposes. Westminster Abbey still possesses a cope woven of pure gold, dating from the fifteenth century, the brilliancy of which is almost perfectly preserved.

Mention has been made of the superior skill of the Flemish in the making of woolen cloths. We must add that they were equally renowned for the magnificence of their tapestries, and in the fourteenth century Flanders produced enormous quantities of woven stuffs. It is recorded that the weavers of Ghent occupied twenty-seven streets; in 1832 there were 50,000 weavers in Louvain, and the number at Ypres was still larger.

In the latter part of the fifteenth century Bruges became conspicuous for the excellence of its silken textiles, and the satins of that town were in great use for church garments; her damask silks were especially in demand. Nor did Flanders need to fear comparison of her velvets with those of Italy; for magnificence of coloring and rich softness of pile those products of her looms were unsurpassed. Her block-printed linens were renowned in the fourteenth century, while in the fifteenth the reputation of Ypres, for her linens, rivalled that of Bruges for silks.

In France, as in England, the women of the thirteenth century wove on small looms in their household, narrow webs of plain and ornamental fabrics. The earliest damasks of her looms date from the fifteenth century. Her velvets were satisfactory, and cloth of gold very good. Some very beautiful specimens of fine linen came from the looms of France as early as the thirteenth century.

The manufacture of silk and ribbon had so advanced in England by 1455, that an act prohibiting the importation of those articles was passed on

the petition of certain silk weavers. In 1473 cloths of gold and silver were manufactured in London, and the woolen manufacture not only fully furnished the home demand, but provided a large amount of goods for exportation. The cloth industry languished somewhat in the reign of Henry VII, who invited numbers of the best weavers of cloth from the Netherlands, which imparted new vigor to the industry. In the reign of his successor, Henry VIII, broad looms were introduced for the weaving of broadcloths. John Winscombe, better known as "Jack of Newbury," was the first to introduce them. This worthy was long considered the greatest clothier in England; he had a hundred looms in his house, each managed by a man and a boy. About this time tapestry weaving, so long neglected, was re-introduced by William Sheldon, and maps of Hereford, Salop, Stafford, Worcester, etc., were woven under his direction and are now in the Bodleian Library.

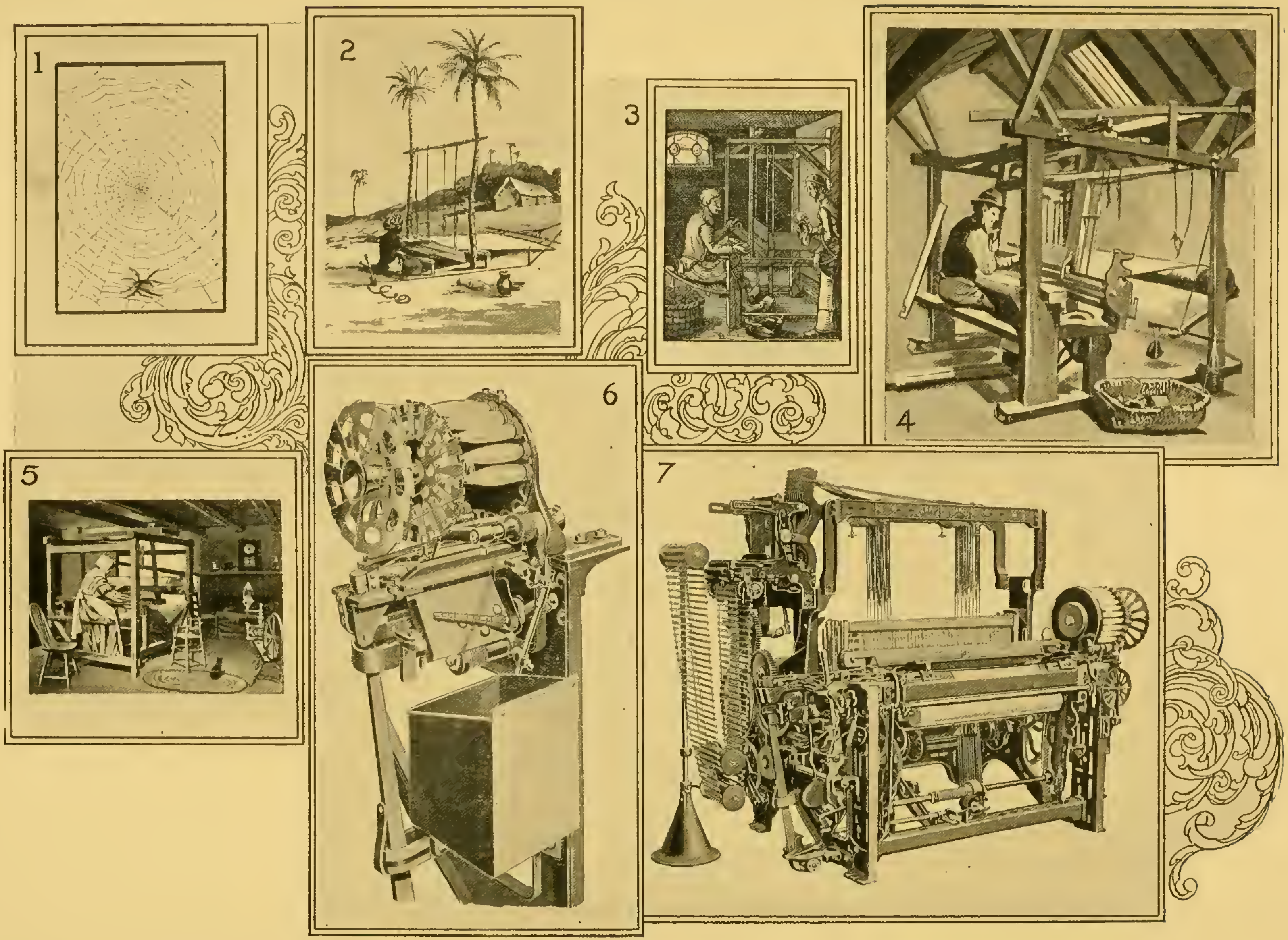
Shakespeare makes frequent mention of weavers and the exactions that were put upon them. The passage in Henry VIII, where Woolsey is charged with taxation, refers to this period. Thus the Duke of Norfolk states:

"Not almost appears,
It doth appear; for upon these taxations
The clothiers all, not able to maintain
The many to their longing, have put off
The spinsters, carders, fullers, weavers who,
Unfit for other life, compelled by hunger
And lack of other means, in desperate manner
Daring the event to the teeth, are all in uproar,
And danger serves among them."

The next important event which had a bearing upon the progress of the art of weaving in England was the influx of refugees from the Netherlands, who were driven from home by the religious persecutors of the Duke of Alod. It is highly probable that the draw loom for damask weaving was introduced into England by them. At any rate they greatly benefited the communities in which they settled by their superior knowledge of the craft. and James I gave encouragement and protection to such of them as suffered from the jealousy and animosity of the English weavers. In 1753 great perfection was attained in the weaving of wrought velvets, branched satins and other kinds of curious silk stuffs, and bombazines were first made in Norwich. The following looms were exhibited in a pageant which passed before Queen Elizabeth, at Norwich, in 1578: "Looms for worsteds, for russets, for darnix, for mockads, for lace, for caffa and for fringe;" and the art of weaving sailcloth for the navy was introduced in the following year.

In 1642 a curious pamphlet mentions the fact that cotton "fustians,

PLATE VII—Weaving



1. Earliest Known Spinner.
2. Hindoo Weaver.
3. Flemish Weaver.
4. Early Kay Fly Shuttle.
5. English Hand Loom in 1845.
6. Northrup Automatic Bobbin Hopper.
7. Northrup Loom.

JAMES H LAMB Co.

vermilions, dymities and other such stuffs" were woven in Manchester. In 1676 the "Dutch engine loom" was introduced into London from Holland. In 1678 M. de Gennes presented his model of "a machine for making woolen cloths without the aid of a workman" to the Royal Academy. In 1685 the Revocation of the Edict of Nantes sent 75,000 French refugees to England, many of whom were silk weavers who settled in Spitalfields, where velvet weaving was introduced in 1686.

It is not necessary that we should in this article give a technical dissertation on the art of weaving as practised in modern times; we have not the space to do justice to so weighty a subject, nor do our readers require such information; but in order to properly set forth the gradual evolution of the art towards the perfection of modern methods and results, we will briefly mention the principal innovations, so far as they relate to the loom, of that brilliant era of inventions which had its inception in 1718 and which revolutionized the weaving and kindred industries and led to the establishment of the modern factory system. In this era America participated at first imitatively, later on taking a leading part in the invention and application of new principles and devices to those already existent. It is necessary, therefore, at this point, that we should retrace our steps and give some account of the previous state of the art in the British colonies in North America. The colonists naturally brought with them the domestic arts of spinning and of weaving. In every household it had been the practice for the women of the family to prepare and spin the wool and flax for domestic purposes, and to weave woolen and linen cloths for the wear of their households. Among the immigrants to the New England colonies were no doubt many of the weaving trade; and in the year 1638 came a little company of these from Rowley, in Yorkshire, and settled about six miles from Ipswich, in Massachusetts, calling the place Rowley. At their head was the Rev. Ezekiel Rogers, a non-conforming minister, whom they had followed when he was ejected from his parish. They established themselves in the manufacture of woolen cloth, that having been their former occupation, and to them, in 1643, came John Pearson from Lynn and established the first fulling mill in this country. During the Protectorate of Cromwell many of the exiles returned to England and there was a greatly diminished intercourse by vessel with England, which necessarily caused the supply of fabrics from the mother country to decline. Consequently, steps were taken by the General Court of Massachusetts for the fostering of the textile industry so far as it related to the weaving of cotton, linen, and woolen cloth, and bounties and other encouragements were given to those who were willing to set up their looms. It is recorded by the Friends who settled Salem, Burlington and other towns in the province of West Jersey that "they soon commenced the manufacture of cloth," and an English writer, in 1697, mentions that they made "very good serges, druggets,

crapes, camblets (part hair) and good plushes, with several other woolen cloths, besides linen."

To Philadelphia, from Crefeld on the lower Rhine, came immigrants who were weavers and who soon acquired a high reputation for their linen fabrics. John Goodson, writing from Philadelphia to Friends in England, in 1690, says: "There are three wool weavers that are entering upon the wool manufacturing in that town, besides several in the country; and five miles off is a town of Dutch and German people that have set up the linen manufactory, which weave and make many hundred yards of pure, fine linnen cloath in a year." J. Leander Bishop, in his "History of American Manufactures," says that the price for weaving linen in 1688 was "ten or twelve pense per yard, half a yard wide," which leads us to understand that the linen was woven not only for domestic purposes, but as a merchantable commodity. In 1699 a law was passed prohibiting the exportation of wool or woolen manufactures from the English plantations in America. In 1705 Lord Cornbury, then governor of the Province of New York, in a report to the British Board of Trade, said: "I am well informed that upon Long Island and Connecticut they are setting upon a woolen manufacture, and I myself have seen serge made upon Long Island that any man may wear. Now, if they begin to make serge, they will, in time, make coarse cloth and then fine. How far this will be for the service of England I submit to better judgment," etc.

Caleb Heathcote, a member of the Council, wrote also to the Board of Trade: "They were already so far advanced in the art of weaving that three-fourths of the linen and woolen used was made amongst them, especially of the coarse sort; and if some speedy and effectual ways are not found to put a stop to it, they will carry it on a great deal further, and, perhaps, in time, to the prejudice of our manufactories at home."

A letter referring to the same subject, written in 1715, gives us a little further insight into the state of the industry at that date: "Nine years before, the great scarcity and dearness of woolen goods, which sold at two hundred per cent advance, had forced them to set up a very considerable manufactory, still in being, for stuffs, Kerseys, Linsey Woolseys, flannels, buttons, etc., by which the importations of these colonies had been decreased fifty thousand pounds per annum."

The historian Bishop writes: "The descriptions of cloth made at this time in America were almost exclusively the stout and coarser kinds of mixed fabrics, into which linen and hempen thread largely entered as a material. Cotton was regularly imported in small quantities, chiefly from Barbadoes, but occasionally also from Smyrna and other places to which trade extended, and was made into fustians and other stuff with linen thread. The linens made at that time were for the most part of quite a coarse texture. The kerseys, linsey woolseys, serges and druggets consisted of wool, variously combined with flax or tow, and formed the outer clothing

of a large part of the population during the colder seasons. Hempen cloth and linen, of different degrees of fineness, from the coarsest tow cloth to the finest Osnaburg or Holland, constituted the principal wearing apparel, outward and inward, at other times. The inner garments and the bed and table linen of nearly all classes were almost entirely supplied from the serviceable products of the household industry. As the implements of manufacture were then comparatively rude, and many modern processes of manufacture and finish were as yet unknown, the fabrics made, whether linen or woolen, were more remarkable for service than for elegance.

The material was mostly grown upon the farms of the planters, the breaking and heckling being done by the men, while the carding, spinning, weaving, bleaching and dyeing were performed by the wives and daughters of the planter. The beauty and abundance of the stores of household linen were an object of laudable pride and emulation with all thrifty families. In 1718 some Protestants in the North of Ireland sent an address signed by 319 persons to Governor Shute, of Massachusetts, and receiving a favorable answer they embarked with their wives and children in five ships for Boston. Some of these settled on a grant of land near Nutfield in 1719, and in 1722 gave the town the name of Londonderry. These people were trained weavers and had brought their looms and spinning wheels, and at once prepared to engage in the manufacture of linen. They grew their own flax, and the linen fabrics woven by them were so superior that imitators sold their wares as being of "Derry make."

Such was the state of the weaving industry in the colonies up to the time of the invention of the fly shuttle by Mr. John Kay, of Colchester, in 1733 This gentleman had already effected various improvements in dressing, batting and carding machines, and various improvements in looms, among them that of substituting blades of metal for strips of cane for the construction of the reed or sley, which became known as "Kay's reeds." He now produced an improvement which ultimately proved of vast importance, and which is to-day a part of every power loom—namely, the fly shuttle, which enabled one man to work the broad loom which had before required two, one at each side of the loom, the shuttle being thrown alternately from one to the other. When the fly shuttle was first introduced, it was intended to use one shuttle only; but later on an improvement was effected by Robert Kay, the son of John Kay, who invented the "drop box," by means of which three or more shuttles could be used for the different colors. (See Plate 7.)

Prior to the invention of the Jacquard loom and other automatic machines, the weaver was compelled to make use of a variety of more or less complicated contrivances in order to successfully produce figured or ornamental fabrics. The ingenuity shown was often very great. Machines there were, it is true, which lent their aid to the hand-loom weaver in the production of figured cloths previous to the adoption of the Jacquard ma-

chine, one of which, the draw loom for weaving damask, was introduced into England about 1567 by the Dutch and Flemish weavers, who fled to various countries and established this branch of weaving. The draw loom is supposed to have been used in Damascus, and a knowledge of it carried to Europe by the Crusaders. The Chinese have a rude description of draw-loom in which the draw-boy stands upon the top of the loom to pull up the neck cords. A weaver's assistant under that name was employed in England, also until the invention of an automatic device for the same purpose, called the draw-boy machine, which performed the same service more perfectly, because of its automatic regularity and the impossibility of its drawing the wrong threads as the draw-boy was apt to do. Several persons have received credit for this innovation, but Joseph Mason, who in 17— patented an engine, "by the help of which a weaver may perform the whole works of weaving such stuffe as the greatest weaving trade of Norwich doth now depend upon, without the help of a draught-boy, which engine hath been tryed and found out to be of great use to the said weaveing trade," was undoubtedly the first inventor. In 1779 William Cheape patented a plan to dispense with the draw-boy machine by drawing down the simple cords which were placed over his head and to hold each cord in a notch while he worked over the treadle.

The "Dutch engine," or ribbon loom, which was invented in Dantzic, Germany, about 1575 to 1589, deserves especial notice as being the first successful power loom known to modern manufacture; it was also called the swivel loom. Prior to its invention ribbons were woven in small looms, and only one ribbon was woven at once; by means of the swivel loom it was possible to weave eight to ten or thirty to forty ribbons at one time. This loom was known in Leyden in 1621, and its invention is claimed for that place; at any rate its use was prohibited, as it was in Dantzic. The State's General renewed the prohibition in 1639, and the use of the loom was prohibited in Nuremberg and in the Spanish Netherlands in 1664. In 1676 it was prohibited at Cologne, and a prohibitive act was passed in regard to it by the Council of Frankfort. The Council of Hamburg ordered one of these looms to be burnt, and Charles VI ordered the prohibition to be renewed in 1719, though the measure was strongly opposed by some of its mercantile advocates. Saxony revoked its prohibition in 1765. In 1676 the "Dutch engine loom" was introduced into England from Holland, and from that time on improvements were made in it both in England and France, so that a century and a half ago and long before Dr. Cartwright's time, the swivel loom had been made self-acting, all the principal operations of the loom being automatic; the shedding of the warp, throwing the shuttle and beating the weft together were effectually accomplished by means of cranks, tappets, etc., almost as at the present time.

In 1745 we have the first account of any improvement in swivel looms in the specifications of a patent granted to John Kay, the inventor of the

fly shuttle, and John Stell; the patent is dated from 1745, No. 612, for a loom for weaving tapes, the specification is of interest as containing what is perhaps the first mention of tappets as applied to a successfully working loom. "The new invention to be added to the Dutch engine or loom now used for working the before-mentioned goods in narrow breadths is by fixing in the lower part of said engine or loom a rowler beam, or round piece of timber, that passes through the length of the said engine or loom and turns round upon its axis at each end, and at a certain distance from one end of the said rowler or beam is fixed a pin made of wood or iron, the said rowler or beam being in part enclosed in a second or other hollow rowler, which moves or slides in a loose position upon the first-mentioned rowler or beam, and is at pleasure fixed to the first by means of a notch that receives the aforesaid pin, and is, by a tender or handle, capable of being moved to and again, or to the right hand and left, which motion, the first rowler or beam being supposed to turn round, sets the said engine or loom to work or stoppeth it at pleasure.

"There are likewise fixed in the sliding beam or hollow rowler, at proper distances, sundry tapits, which, when the said two rowlers or beams turn round, perform the office of treading the necessary treadles and move the batten or lath, and, by the help of the other piece of timber or part of the machine fixed upon the aforesaid batten or lath, in the form of the letter T or angle, which plays upon an axis at the centre of the top or head, and by two treadles annexed to the extremity of each uppermost angle, the aforesaid tapets, laying hold and treading down the treadles aforesaid and throws over the shuttles to the right hand and left by means of the lowermost or third angle, being annexed to a certain part of the said engine or loom, called a driver, and is further assisted by a balance or weight, and the batten being stuck to the piece or web by a weight or spring closeth the shoot and completes the work, and the said engine may go or be worked by hands, water or any other force." In Kay's specification there is no mention of the bar which may have been added by Vaucanson, the first mention of it being in Diderot and d'Alembert's Encyclopedia, 1762. Sir Edward Baines, in his "History of the Cotton Manufacture," mentions a swivel loom invented by Vaucanson, and in 1765 a weaving factory, built by Mr. Gartside, was filled with swivel looms; but whether these were McKay and Stells or Vaucanson's is indeterminate. At any rate, the bar or swivel loom can hardly be regarded as any other than the first successful power or automatic loom. Minor improvements have since been made, such as the employment of different tiers of shuttles, but none of these improvements affect in any way the principle of the loom. The ribbon loom may be regarded as "a series of distinct looms, mounted within one frame, each having its own warp and cloth beams, heddles and shuttle, but all worked by one set of treadles and with a single batten. The Jacquard ap-

paratus and the drop-box arrangement for changing shuttles have been applied to this valuable machine.

Mr. Thomas Morton, of Kilmarnock, Scotland, invented a barrel or cylinder loom for fancy weaving. The improvement consisted of the use of a barrel or cylinder, "on the surface of which the figure or pattern to be produced in the cloth is arranged in relief, precisely the same way as tunes are disposed on the barrel of the common organ, or on that of a musical box, by inserting wire staples or wooden pins and the barrel being placed upon the top of the loom; these staples actuate other suitable mechanism, and thus the pattern is formed upon the cloth.

But the most important and ingenious appliance that has ever been adapted to weaving was in course of evolution; a machine by means of which it has become possible to produce the most intricate and extended patterns with the same certainty and with almost the same rapidity as plain cloth—namely, the Jacquard loom. Although the germ of the idea had been conceived by Bouchon, who, in 1728, patented in France the application of perforated paper for working the draw loom, and by Falcon, who, in 1728, substituted a chain of cards to turn on a prism or cylinder in lieu of the paper band of M. Bouchon, and by M. Vaucanson, who, in 1745, applied the griffe to M. Falcon's invention and placed the apparatus on the top of the loom in the position it now occupies in the Jacquard loom, still, the credit of making the machine of practical utility and of introducing it to the world is due to Joseph Marie Jacquard, of Lyons. M. Jacquard began his experience in 1801 at the request of Napoleon, and when first introduced in France the machines met with much opposition; they were dismantled and burned; but after some years the inventor had the satisfaction of seeing the merits of his loom fully recognized. (See Plate 8.)

In 1816 Mr. Stephen Wilson introduced the Jacquard loom into England, and he is credited with having effected several improvements in it. Before a Lords' Committee on the silk trade, in 1823, Mr. Wilson said: "If I am not too sanguine, my idea of this machinery is that it is of as much consequence to the silk manufacture as Arkwright's machine was to the cotton, and that it will supersede a great many of the machines now in use." The general efficiency of this loom has from time to time been greatly augmented by scientific and practical weavers both in America and Europe. In 1822 the Jacquard loom was first set up in Coventry, England; in 1823 there were five of these looms in that town; in 1832 there were 600; and in 1838 2,228. The Jacquard loom has in the progress of manufacture been applied to various purposes, notably to the making of lace, of counterpanes, and so forth. It is very simple in its construction and almost unlimited in its extent and scope, and well deserves the high estimation in which it has ever been held. Some noted examples of early work done by the Jacquard were the weaving of Queen Victoria's coronation dress, in which thirty colors and as many shuttles were used; and a night shirt for Pope Boniface,

in the production of which 276 shuttles were employed; the pattern displayed correct likenesses of 276 heretics, each suffering under some species of torture different from the others; signs which must have produced a garment variegated in its effect, but terrible to contemplate or to wear. More happily inspired was a still more extraordinary specimen of silk weaving, executed by Didier, Petit & Co. This was a portrait of Jacquard, representing him in his workshop, surrounded by his implements and engaged in the construction of the machinery which thus rendered its testimony to the genius of its inventor. This work, entitled, "Hommage â J. M. Jacquard," was woven, "says one who saw it," with such truth and delicacy as to resemble a fine line engraving. In 1893 Messrs. Norris & Co. exhibited at the International Exhibition a Spitalfields loom, weaving a rich damask from a design by the late Owen Jones. There were 29,088 warp threads, the design, when woven, being twenty-eight inches long and requiring 9,312 cards, weighing five and one-half hundredweights for its formation. To cut these cards, the design on ruled paper measured sixteen feet by nine feet three inches. Portraits and pictures have frequently been produced of such artistic character that they had all the appearance of fine engravings.

Another very interesting piece of weaving on the Jacquard was designed by a Mr. Balfour and manufactured by the Messrs. Dewar at the Bothwell factory, Dunfermline, about fifty years ago—namely, the "Crimean Hero Tablecloth." A cloth of this pattern was exhibited at the display given by the textile Exhibitors' Association in Mechanics' Hall, Boston, in 1909.

"The designing and executing of the work occupied about eight months and occasioned an outlay of nearly $3,000. The cloth is composed of the finest linen warp and white silk weft, six and a half yards in length and three in breadth; but when woven for sale it would consist of linen only. The pattern consists of a beautifully elaborate leafy scroll-work for border, in which, at proper intervals, are inserted twenty-four faithful portraits. In one border is Her Majesty Queen Victoria in the centre, and on either side are the Prince Consort and the Duke of Cambridge. In the other end border is the Emperor Napoleon in the centre, and on either side is the Empress Eugenia and Prince Napoleon. In the centre of one of the side borders is placed the King of Sardinia, and on either side Bosquet, Brown, Florence Nightingale, La Marmora, St. Arnaud, Dardigan, Raglan and Bruat. In the other side border, the Sultan in the centre, with Omar Pasha, Williams, Canrobert, Evans, Campbell, Pelissier, Lyons and Simpson on either side. Each portrait of the sovereigns is surmounted with their respective armorial bearings, placed towards the middle of the cloth; and alternately with these are trophies containing the names of the chief battles with their dates, and in the centre of the cloth there are magnificent trophies illustrative of the fall of Sebastopol, with the motto "Deus proteget justitiam" and the date, 8th September, 1855; the ground around all of

these being interspersed with the stars and orders of the different sovereigns, etc., etc.

"An idea may be formed of the extent of the design when it is mentioned that there were 50,000 cards and seven 600-cord Jacquard machines employed in forming the pattern on each loom. These machines are required to be kept in operation at the same instant, and the whole was put in motion by a single movement of the foot. The web was 1,600 threads in the reed, equal to 4,800 threads per yard, or a total number of 14,400 in the breadth of the cloth."

Much more of vast interest might be written in regard to the capabilities of the Jacquard machine, but we must now give some account of the development of machines for automatic weaving. The application of power to the weaving of ordinary webs developed along a different line. So early as 1678 a machine for making "linen cloth without the aid of a workman" was invented by M. de Gennes, a French naval officer, and was figured and described in the French Journal des Scavans. M. Vaucanson's loom of 1745 embodied several improvements on that of De Gennes and foreshadowed the Jacquard; in fact, had M. Vaucanson been acquainted with the fly shuttle, which was then known and used at least in England, he would no doubt have come down to fame as the inventor of both the power loom and the Jacquard. "This loom is of full size and is now carefully preserved in the Conservatoire des Arts et Metiers, at Paris. It not only is provided with his improvements on M. Ponchou's invention, by which he "suppressed altogether the cumbrous tail-cards of the draw loom and made the loom completely self-acting by placing the pierced paper or card upon the surface of a large pierced cylinder, which travelled backwards and forwards at each stroke and revolved through a small angle by ratchet work. He also invented the rising and falling griffe and thus brought the machine very nearly resembling the actual Jacquard, but it contains a friction roller taking-up motion. These two inventions are now in common use." The next attempt to produce a power loom was made by Robert and Thomas Barber, of Nottingham, who took out a patent in 1774, No. 1083, for "Machinery for preparing, spinning and weaving fibrous substances," etc. In this loom the "picking shafts, with the sticks, cams and studs, are arranged the same as in the most approved modern looms, although they act by winding up and releasing springs as in some excellent looms now in use." (Barlow's "History of Weaving.") But it does not seem that this loom ever came into practical use, and, although from time to time power looms made their appearance, the practical adoption of machines for automatic weaving was deferred for upwards of forty years. But a great step towards the application of a motive power to weaving had been accomplished by the invention of the fly shuttle and the addition of the "tappet shaft" to the Dutch loom, and the spinners could not supply yarn in sufficient quantities to keep the looms running. The demand led to the grand series of inven-

tions used in spinning, and so amply was the deficiency supplied that it was soon evident that the weavers would be unable to keep pace with the production of yarn. But necessity was ever the mother of invention. In 1784 Dr. Edmund Cartwright, a learned divine, as well as a scientific agriculturist, was led, in a conversation with some Manchester gentlemen, to consider the idea of inventing what he termed a "weaving mill." We will give the account of his procedure in his own words, as given in a letter to his friend, Mr. Bannatyne: "Some little time afterwards a particular circumstance recalling this conversation to my mind, it struck me that, as in plain weaving, according to the conception I then had of the business, there could only be three movements, which were to follow each other in succession, there would be little difficulty in producing and repeating them. Full of these ideas, I immediately employed a carpenter and smith to carry them into effect. As soon as the machine was finished, I got a weaver to put in the warp, which was of such materials as sailcloth is usually made of. To my great delight a piece of cloth, such as it was, was the product. As I had never before turned my thoughts to anything mechanical, either in theory or practice, nor had even seen a loom at work, or knew anything of its construction, you will readily suppose that my first loom was a most rude piece of machinery. The warp was placed perpendicularly, the reed fell with the weight of at least half a hundredweight, and the springs which threw the shuttle were strong enough to throw a congreve rocket. In short, it required the strength of two powerful men to work the machine at a slow rate, and only for a short time. Conceiving in my great simplicity that I had accomplished all that was required, I then secured what I thought was a most valuable property by a patent—4th of April, 1785. This being done, I then condescended to see how other people wove, and you will guess my astonishment when I compared their easy modes of operation with mine. Availing myself, however, of what I then saw, I made a loom, in its general principles nearly as they are now made. But it was not until the year 1787 that I completed my invention, when I took out my last weaving patent, August first in that year." (See sketch of Dr. Cartwright, *Ibid.*)

In 1786 the inventor had established a weaving and spinning factory at Doncaster, in which free scope could be given to every description of mechanical experiment, but after spending thirty thousand pounds in the enterprise, he was compelled to abandon it in 1793. In 1791 Dr. Cartwright contracted with Messrs. Grimshaw, of Manchester, for the use of four hundred of his looms. A mill was built for the purpose, and twenty-four of the machines were set to work, but shortly afterwards the factory was burned down, it is supposed by a mob. To this unfortunate circumstance Dr. Cartwright ascribed the origin of his misfortune, for he became unable to prevent the infringement of his patents. His loom even then contained many features which were highly ingenious, though quite impracticable as he developed them, but which have since been brought to perfection by more

practical inventors. One of these was a device for the automatic stopping of the loom on the breaking of a warp thread, and the principle upon which the contrivance is based is now applied to the warping frame. In his various patents he described a method for stopping the loom on the breaking of a weft thread, and also let-off and take-up motions for the warp and cloth beams. But so manifold were the imperfections and crudities of the Cartwright loom that (we quote Mr. G. C. Gilroy) "it is certain that this machine would have long since passed into oblivion had it not been for the improvements made upon it by other men of genius." Inventors who followed the doctor confined themselves to motions that were absolutely necessary, but, even so, it took twenty years of untiring effort to prove that the power loom possessed any advantages over the hand loom. Many of these attempts proved impracticable, being worked by a crank, as Richard Gorton's, 1791, and Stephen Dolignon's "loom to weave by a machine rocking to and fro by gravity."

Some that were more successful were: Andrew McKinlock's power loom, which, with the assistance of a carpenter and clockmaker, he set up in Glasgow in 1793. This machine was propelled by hand power, and he later built forty of the machines, in which he had made some slight improvements. These same looms were working at Pollockshaws and Paisley in 1845, when the inventor was still living at the age of eighty-five. Also Robert Miller's power loom, long known as the "wiper loom," from the circumstance that the picking and treadle motions were worked by cams which were called "wipers," and for which he obtained a patent in 1796. Mr. Monteith erected two hundred of these looms at Pollockshaws in 1801. Then, in 1803, William Horrocks invented a loom which afterwards came into very general use. Mr. Horrocks was accused of having appropriated a take-up motion embodied in a hand loom invented by Mr. Radcliffe in 1802, and which was known as the "Dandy loom;" the motion, in fact, was one embodied in Vaucanson's invention of 1745, had they but known it.

In 1805 a large power-weaving factory was erected by James Finlay & Co. at Catrine in Ayrshire. Indeed, power looms were being set up everywhere, and by 1813 there were 2,400 power looms in operation in Great Britain, but hitherto they had shown no advantage over hand looms, and by some it was predicted that they would never prove of any service. The weaving of textile by machinery was, however, progressing towards ultimate success, and in 1820 it was estimated that there were 12,150 power looms in operation in England and 2,000 in Scotland. A little over fifty years later the number had increased to 700,000.

Meanwhile, in the colonies, the art of weaving was progressing steadily. Most of the early immigrants being mechanics, a fair proportion of them were necessarily weavers or fullers, and we find records of the early establishment of small centres of the weaving industry. In 1767 we learn that 17,000 yards of cloth were manufactured in East Hartford, Conn., and

in the same year they were making broadcloth, serges, tammys, shalloons, camblets, figured stuffs, etc., at Scituate, Mass.

In 1764 a society was formed in New York, styled: "The Society for the Promotion of Arts, Agriculture and Economy," the object of the society being "the encouragement, to the utmost, of the manufacture of linen." From its inception, the society offered premiums for both the raw and manufactured goods.

Silk goods were not manufactured for sale, but they were woven for home use by several ladies; the stuffs, however, for lack of proper knowledge of the preparation of the raw material, were crude, being fuzzy as well as stiff. "In 1770 Mrs. Susanna Wright, at Columbia, Lancaster County, Pa., made a piece of mantua, sixty yards in length, from her own cocoons, and it was afterwards worn as a court dress by the queen of Great Britain."

In 1775 a society was formed in Philadelphia, having for its object the promotion of the weaving and spinning industries; and a factory was established for the production of woolen and cotton cloths, which was closed in September, 1777, when the British occupied Philadelphia. On the evacuation by the British troops, the buildings and machinery lay idle for some time and were later put into operation by Samuel Wetherall. Such was the state of the weaving industry in 1776. The patriotic spirit of the people soon, however, gave an impetus to the infant industry, and woolen, cotton and silk mills sprang up everywhere.

In 1812 Thomas R. Wililiams, a watchmaker of Newport, set up his first power loom in the factory of Rowland Hazard, in Newport, R. I.; this was "a rotary loom for weaving boot, suspenders and girth webbing." But, although Mr. Taft, in his "Notes," says of them: "It is most probable that they were the first power looms successfully operated in America," we have the evidence of Mr. Isaac Hazard that they were "so imperfect that they did not make the web equal to that produced by hand, and the business did not succeed." Improvements in machinery were, however, constantly being made in looms, this being the experimental stage of power weaving both in England and America.

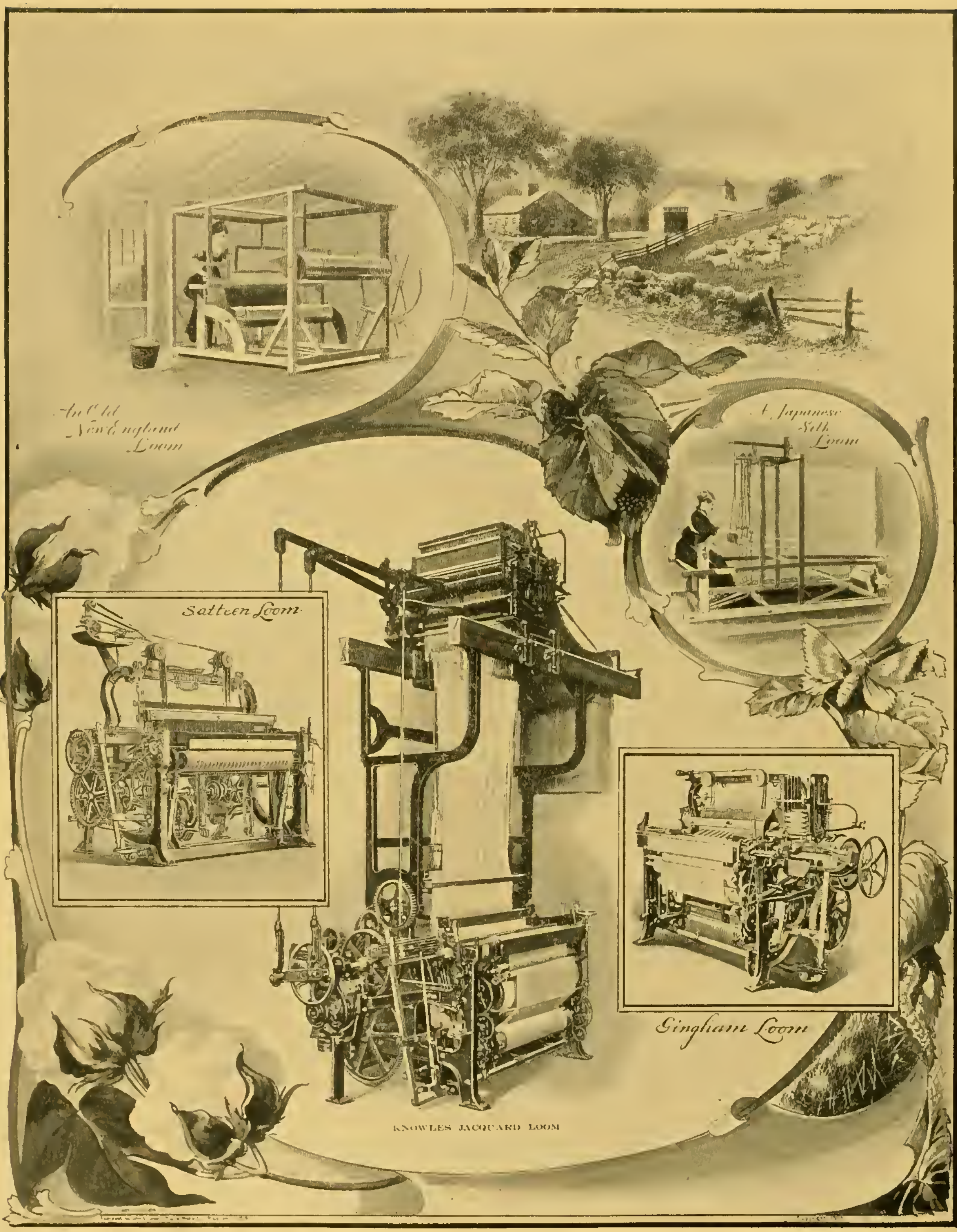
In the year 1810 Francis Cabot Lowell visited the factories of England and Scotland with the purpose of studyinig the methods employed there and also the machinery. Mr. Lowell returned to America with his notes and drawings in 1812 and began the construction of a power loom, in which he was aided by Patrick Jackson. The first Lowell loom was operated by means of a crank turned by a man. The next three years were spent in perfecting a loom for which a patent was issued to Lowell and Jackson, February 23, 1815, and the looms were set up in the factory of the Boston Manufacturing Company at Waltham, Mass. A subject for constant invention in the new power looms were the temples, it being a matter of great importance to make the temples automatic. Dr. Cartwright was the first

to attempt to accomplish this; he applied to his loom (1786) temples closed by a spring and opened by the motion of the treadles. In 1805 Thomas Johnson, the same who was employed by Mr. Radcliffe, obtained a patent for rotary temples formed like bevelled wheels, with pins in the edges to hold the cloth distended; in 1816 Ira Draper, of Weston, Mass., also invented a rotary temple, which was patented January 7, 1816; he obtained a patent for improvements upon it in 1829. These temples came quickly into general use in this country, and the Draper Company now furnishes practically all of the loom temples used in the United States.

In the following year, 1816, the power loom was introduced into Rhode Island by William Gilmour, a machinist from Glasgow, Scotland. He was employed by Judge Lyman to construct a power loom for the Lyman Cotton Manufacturing Company. This was the loom invented by William Horrocks, of Stockport, England, and was first patented in 1803 and then improved and re-patented in 1805 and 1813; it was known in this country as the "Scotch loom." Twelve of these looms were put into successful operation in the Lyman Mills in 1817. Judge Lyman's policy in regard to this loom was unusually liberal; he allowed the use of all his drawings by other mill owners, the result being that power looms were rapidly introduced into all the cotton mills of the country. As a mark of gratitude to Gilmour for the introduction into this country of the power loom, the cotton manufacturers of Rhode Island, Massachusetts, and Connecticut subscribed $15,000 as a purse for him.

From this time on the woolen and cotton weaving industries of the United States progressed rapidly towards the high standing they possess to-day. A loom for the production of figured fabrics was the next hugely important addition to textile power machinery, for up to this time power looms had produced only plain fabrics. In 1837 came to these shores from the cradle of the cotton industry, Lancashire, England, one William Crompton, by trade a weaver, by genius an inventor, who, at the suggestion of his employers, Messrs. Crocker & Richmond, Taunton, Mass., and aided by their American enterprise, produced at their mills a power loom for weaving figured cotton fabrics, for which he obtained a patent in 1839. It was the first of its kind in the world; and when, at the suggestion of Samuel Lawrence, of the Middlesex Mills, Lowell, he applied the principle of his loom to the weaving of fancy worsted cassimeres, material which had never before been produced on any but hand looms, the importance of his contribution to the textile art was enhanced beyond estimation. The looms were manufactured principally at Worcester, Mass. On the lapse of the first patents an extension of them was granted for seven years to the inventor's son, the late George Crompton. In 1856 an open-shed loom was invented by Lucius J. Knowles, and forty years later the Crompton-Knowles Loom Company was incorporated. (See Plate 8.)

PLATE VIII—Loom



Furnished through the courtesy of Crompton & Knowles Loom Works.

JAMES H LAMB Co.

Space will not permit us to mention the improvements that have from time to time been attempted or perfected by numerous inventors since the invention of the power loom by Dr. Cartwright; probably the most important that has been effected since the weft-fork (Clinton & Gilroy) and grid-stop motion, the automatic let-off motions and parallel shuttle motions is that embodied in the Northrup loom—namely, a device for changing filling in the shuttle, with which was incorporated a warp stop-motion. This was the invention of James H. Northrup, an Englishman who came to the United States in 1881. Mr. Northrup, who had previously invented the Northrup Spooler Guide, first produced a shuttle-changing device and applied it successfully to looms of the Draper Company at Hopedale, Mass. His idea of changing the filling instead of the shuttle began to take shape in 1889, and under the auspices of the Draper Company he continued his experiments and brought his idea into practical shape in April, 1890, when a completely new loom was devised, incorporating his new improvements and various others, and the Northrup loom has since taken a leading place both at home and in many foreign countries. American inventors have been particularly prolific in the production of many kinds of devices for the improvement of textile machinery.

The weaving of silk was attempted between 1828 and 1844 by the Mansfield Silk Co., but these efforts resulted in failure. This, however, was retrieved by their successors and others, so that in 1850 there were, in various parts of the United States, sixty-seven establishments reported as manufacturing silk goods, and America is now (1911) the second country in the world in the production of woven silk materials. One striking feature of this industry is the marked increase in the use of power looms and the decrease in that of hand looms. Credit is due to the silk manufacturers of the United States for being the first to produce silk taffetas by power looms, an innovation which was so successful as to be copied later in Europe; the importance of this improvement is shown by the fact that one-half the product of the silk looms in the United States come under the head of "taffetas."

The application of electric and pneumatic power to looms will properly be treated of in the article specially pertaining to machinery. The art of weaving has now become so systematized that we are apt to regard it as a mechanical operation rather than as an art. Perfect as are the materials put out from the factories of to-day, they cannot excel the products of the looms of the ancients, nor those of the middle ages, and with some of them they cannot even compare. In this utilitarian age, however, quantity as well as quality is a desideratum.

A notable exception in this respect must however be made in regard to Japan, where the textile art acquired a very high degree of perfection ages ago. In old Japan, it was the custom for each noble to have his private looms for weaving brocades for the wear of himself and his fam-

ily, and also the less costly fabrics in which his retainers were clothed. The robes manufactured for the Court at Kyoto and Yedo were supplied only by the imperial looms. The common fabrics, such as towels and dusters, often displayed very artistic designs—a flight of birds, a branch of blossoms, etc. Japan has made immense progress in the textile art during recent years, and in no branch of applied art does her decorative genius show to better effect than in her textile fabrics, and, unlike other ancient nations, the art of weaving has not fallen into decadence in that country. The woven and embroidered stuffs of Japan have always been beautiful, but in former times, with the exception of hangings for the temples and for the drapings of festival cars, few pieces of size or splendor were produced. But of late years, arras of immense size, showing remarkable workmanship and grand combinations of colors, are now manufactured at Kyoto. Kawashima, of that place, inaugurated this new departure by reproducing a gobelin, but it may now be safely asserted that no gobelin will bear comparison with the pieces produced in Japan. The fashion of weaving, which has been in use for three hundred years, is called "tsuzure-ori" or "linked weaving;" the cross threads are laid in with the fingers and pushed into their places with a comb by hand, very little machinery being used. The threads extend only to the outlines of each figure, so that every part of the pattern has a rim of minute holes, like the pierced lines between postage stamps, the effect being that the design seems to be suspended in the ground. A recent example of this nature required two years of incessant labor, with relays of workmen working steadily throughout the twenty-four hours. This piece, manufactured by Kawashima's weavers, measured twenty by thirteen feet, and we quote the following description of it. "It represented the annual festival at the Nikko mausolea. The chief shrine was shown; the gate and long flight of stone steps leading up to it, several other buildings, the groves of cryptomeria that surround the mausolea, and the festival procession. All the architectural and decorative details, all the carvings and colors, all the accessories—everything was wrought in silk, and each of the 1,500 figures forming the procession wore exactly appropriate costume. Even this wealth of detail, remarkable as it was, seemed less surprising than the fact that the weaver had succeeded in producing the effect of atmosphere and of aerial perspective. Through the graceful cryptomeria, distant mountains and the still more distant skies could be seen, and between the buildings in the foreground and those in the middle distance atmosphere appeared to be perceptible." The fabric next to tsuzure-ori, in decorative value, is that styled yuzen birodo, or "cut velvet." Dyeing by the yuzen process is quite modern. The design is painted on the fabric, after which the latter is steamed and the picture is ultimately fixed by methods which are kept secret." Silken fabrics are preferred for this style of decoration. When cut velvet is the material, the yuzen process is supplemented by the work of the cutter, whose tool is a small, sharp chisel with a V-shaped

point with which he carves into the pattern as though he were shading the lines of the design with a steel pencil, the edge of the tool never being allowed to trespass upon a line "which the exigencies of the design require to be solid. The veining of a cherry petal, the tesselation of the scales of a carp, the serrated edge of a leaf, these remain intact, while the leaf itself, or the scales of the fish or the petal, have the threads forming them cut, so as to show the velvet nap and to appear in soft low relief. The elaborate and microscopically correct pictures produced by the yuzen process are better displayed on silk crape or habutaye. The rich-toned, soft plumage of birds, or the blending of the colors in a branch of chrysanthemums or peonies cannot be produced with like fidelity on the unequal surface of velvet.

A very interesting survival of the mediæval style of weaving still exists in Sweden and other Scandinavian countries, and table covers, counterpanes and articles of dress are woven by the peasantry in a simple but highly decorative way, many of the patterns being of great artistic beauty.

THE ORIGIN AND PROGRESS OF THE ART OF KNITTING

There is great uncertainty as to the origin of the art of knitting by hand: the period, the country, and the author of the invention are not known beyond a doubt. Some authorities claim Scotland as the birthplace of this industry at a date somewhat earlier than 1500. There is no historic mention of the art until the time of Henry IV and it was first named in an act of Parliament in the reign of Henry VII; and in seven following Acts, knit hose, caps, and also hosiers were mentioned; the latter might, it is true, have been the fashioners of the earliest hose, which were made of cloth sewn to the proper shape. Knitted hose cannot, however, have come into general use, or perhaps the common woolen hose was too coarse for the king's wear, for it is on record that Henry VIII himself wore hose fashioned from woven materials, "except there came from Spain, by great chance, a pair of silk stockings." This circumstance and the fact that Sir Thomas Gresham presented the young King Edward VI with a pair of silk stockings which probably came from the same country, gave rise to the idea that the art originated in Spain or that the Spaniards might have acquired it from the Moors. But as knitted woolen caps were commonly worn in England in the reign of Henry VII, and there is no evidence that the Spanish stockings worn by the succeeding monarchs were knitted, the preponderance of evidence still remains in favor of Scotland. Then again, Stowe, the historian, states that "in 1564, one William Riley, apprentice to Master Thomas Burdett, having seen in the shop of an Italian merchant, a pair of knit worsted stockings from Mantua, borrowed them and made a pair exactly like them, and these are said to have been the first stockings of woolen yarn knit in England;" but it is said that worsted stockings were made at that time in England, and that they were very likely silk stockings which young Riley imitated and which were worn by the Earl of Pembroke.

In 1560, we are told of Elizabeth, that "Mrs. Montague, her highness's silk-woman, presented the queen with a pair of black silk knit stockings, which after a few days' wearing pleased her highness so much that she sent to Mrs. Montague for more. The queen, who was not ignorant of the attraction of a smart-looking foot and ankle, liked them so that she would not henceforth wear any more cloth hose," and we learn that in 1578, at the pageant exhibited to Queen Elizabeth at Norwich, were portrayed: "Looms for worsteds, for russets, for darnix, for mockads, for lace, for caffa, and for fringe; and upon the stage at one end stood eight

small women children spinning worsted yarn, and at the other end many knitting worsted hose."

About 1589, an invention truly wonderful considering the state of manufacturing at that period was produced by William Lee, a curate in the parish of Calverton, about five miles from Nottingham. This was a stocking frame, which was probably the first automatic machine for the purposes of manufacture.

Mr. Lee was engaged for about three years in perfecting his invention, with the assistance of his brother and some skilled artisans of Nottingham, and in the year 1589, it was completed and was put into operation and worked for about two years. But becoming aware of a prejudice against it, he removed it to London, where it was set up in Bunhill Fields, St. Lukes. Here Mr. Lee met with varying success, and as he had expended the greater portion of his patrimony and even endured much privation while employed upon his loom, in order to secure some profit from it he endeavored to obtain a patent for it from Queen Elizabeth, who went to his lodgings accompanied by Lord Hunsdon, and there saw it worked by Lee or his brother. She was disappointed when she found it knitting coarse worsted instead of silk hose and refused to grant the patent, although urged to do so by Hunsdon.

In 1598, Mr. Lee succeeded in making a machine that produced silk stockings. His friend, Lord Hunsdon, dying, Lee fell into deep melancholy, and being invited to France by the minister of Henry IV, he went, taking his machines with him. Before he could establish himself in business, the king was assassinated and Lee died in Paris, in 1610. His brother, James Lee, who was at that time in Rouen, where they intended to carry on the manufacture, went to Paris and found that his brother was dead and buried. He returned to Rouen and with the seven workmen who had gone over with the machines, he recrossed to London. One of the looms, however, was left at Rouen with two of the workmen who desired to remain there, hoping to profit from Lee's privilege. One of these men soon died, the "other worked on his unimproved loom for forty years."

The looms brought back to London were set up in Old Street Square, and formed the foundation of the "London Hosiery Manufacture." The machines in a short time were sought after and sold, and Mr. James Lee went to Nottingham, where he went into partnership with one of his brother's old acquaintances, named Aston, and began to make new frames in 1620, when Aston made a very important improvement in the machine by dispensing with a set of "sinkers."

In 1621, the Venetian ambassador in London paid Mr. James Lee five hundred pounds, for a machine, and the release of an apprentice to go with it. But the Venetian smiths were unequal to the business of building or even repairing a stocking frame, and the enterprise failed. From this time

forward, the business of stocking weaving rapidly extended, London, Godalming and Nottinghamshire being the chief centres of the industry.

A union was formed early in the seventeenth century under the title of the London Framework Knitter's Company, for regulating wages and opposing knitters who had failed to serve an apprenticeship. In 1640, there were at Nottingham two master hosiers who purchased country-made goods, the machines being leased by the knitters and the work done in their cottages. The manufacture spread, and silk, worsted and cotton hose were made also in Leicestershire and Derbyshire. Much prejudice existed against machine-wrought hose, but in spite of this the trade grew and prospered. Owing to their grievances against a stocking maker, named Pickards, the "London Knitters' Company" applied to Cromwell the Protector for a charter; alleging that "Pickard taught his art to anyone for money; made under-fashioned and unsound hose; and of slightly twisted yarns." The Charter of Incorporation was granted in 1657, and it empowered the company, "to make laws consistent with the custom of London, of which city they might choose any citizen as a member; might levy fines by distress, and search for and prove any framework knitted goods; and if found ill-made or of deceitful stuff, cut them to pieces." It was also ordered that no frames should be exported. Every stocking maker was to become a member of the company or pay five pounds weekly until he did so. A second charter with extended powers was granted to the company by Charles II in 1660, and yet a third in 1686, which extended all previous and some further powers to Ireland, where many frames were at work. More than four hundred frames having been exported, a fine was levied on the removal of one without notice, and all were numbered, which stopped the exportation. In 1695, there were 1,500 frames in and near London. In 1727 there were 2,500 frames in and around London and 55,000 in the provinces. But many of them were unemployed, a circumstance which was largely due to the taking of an undue number of apprentices. A man in Nottingham had on an average twenty-five apprentices, and did not employ a journeyman for a period of thirty years. Cartwright, who had twenty-three, and Fellows, who had forty-nine apprentices, removed their frames from London to Nottingham in 1710, in consequence of frame-breaking having taken place in London. The London Company fined Cartwright one hundred and fifty pounds and Fellows, four hundred pounds, and on their refusal to pay, their machinery was sold; but the legality of the proceedings being disputed, the authority of the company was overthrown by a committee of the House of Commons in 1753, as tending to a monopoly hurtful to trade, and the rulings of the company had effect only in London.

In 1730, the first stockings of cotton yarn were made. Up to the year 1750, no attempt had been made to add machinery to the stocking-frame so as to vary the face of the web, but in that year a sliding tuck pressure

was applied. Hand knit-ribbed hose were much worn because of their closely fitting the leg, and efforts to produce this ribbing effect on the stocking-frame were unsuccessfully made by several. Woolett, a hosier at Derby, brought this question to the notice of his brother-in-law, Jedediah Strutt, who added to the Lee stocking-frame an apparatus termed the "Derby rib machine." in which the principle was introduced of "operating upon any one or more of the loops or meshes of a web, by the addition of an independent selecting apparatus." The importance of this new device was not recognized at first, its simplicity and the ease with which it could be applied to the stocking frame prevented its full merit from being discerned, but it contained the fundamental principle of all subsequent methods for alternating or altering the course of threads at work on either lace or hosiery machinery, and consequently the face of the webs and texture of patterns introduced into them.

This new and ingenious device did not require any alteration of Lee's stocking-frame; it was wholly and simply an addition to it. The Derby rib machine consisted of an apparatus constructed of iron, in which needles like those in the ordinary frame were placed perpendicularly, so as to enter between the horizontal ones of Lee's frame. This apparatus is hung on jointed arms in front of the frame, and by its swinging motion the needles of the new machine are caused to "enter between the old ones, penetrating only those loops which are to form the ribs; and these, passing under their beards, are reversed, and then pressed again, passing over the needle heads with the other loops, but with the visible parts of the ribbing loops turned the other way. The ribs may be varied in width from one and one, *i. e.*, every other loop, as in sock tops, to any number required by the weavers."

Patents were granted to Woolett and Strutt in 1758-9, and their business grew very rapidly. The success of the invention, when its advantages began to be fully comprehended, was such that it incited other ingenious men to effort, and numerous further inventions were the result. Many of these were really infringements and actions were brought with success against associations of hosiers, and the patent rights were secured. Strutt's principle of control and selection, variously modified and applied, produced in succession the knotted, twilled, stump, mesh, and point net machines. "In the warp frame," writes W. F. Felkin, in his history of the Hosiery and Lace Manufacture, "where no weft thread is used, but each warp thread loops sideways on its neighbor, every needle, in its wide horizontal range, can be similarly selected and governed in its action. Thus, not only did fancy hosiery modifications cause a large and growing increase of production, but all the machine-wrought plain and fancy lace manufacturers of England and the Continent owe their rise and much of their extension and value to the example set in the added mechanism of Strutt."

In 1764, Morris and Betts obtained a patent for making a machine

fixed to a stocking-frame, eyelet holes or net work, having an additional row of frame tickler needles. The new device was in reality the production of Butterworth, a stocking weaver at Mansfield, who was robbed of the fruits of his talent and labor by those who pretended to aid him.

Mr. Crane, of Edmonton, in 1775, effected a most important modification of the stocking-frame—namely, the application of a warp to the stocking-frame—this invention gave rise to numerous devices and applications for the production of fancy webs and patterns. Among the various modifications of the stocking-frame for the purpose of producing open or figured work, perhaps that best worthy of mention is the device of William Dawson, a framework knitter of Leicester, who conceived that "the edge of a wheel might be notched in such a manner that when rolled over the parts controlling the figure it would act upon them accordingly and produce a similar effect to the use of pegs in a barrel organ." The wheels were well adapted for circular machines and are to this day known as Dawson's wheels. This clever inventor patented in 1791 "a machine for making all kinds of hosiery." When the patent expired he craved an extension of it, which, being denied him, he took his life. Else and Hammond eliminated the tuck presser and substituted therefor a sliding needle bar and a side motion for which they received a patent; then in 1769, R. Frost produced a figured net on a stocking loom by a device which will be later explained in the article pertaining to lace. Ross produced in 1767 a velvet pile on the frame by cutting rows of slack loops; Crane patented in 1769, a method of producing handsome brocades using a cylinder roller and drawboy in selecting the needles. In 1771 and 1776, March and Horton took out patents for knotted hosiery and double-looped work. This was the invention of Horton, who was perfectly acquainted with the mechanism of the stocking-frame, and seeing a workman making a tuck stitch diamond on the hand of a glove, he proceeded to use Lindsey's tickler frame on Else's plan with his own adjustments. He improved his machine in 1776 and obtained another patent. "He succeeded in knotting every loop of the web, thus making an elastic and sound fabric that would not rive when the thread was broken." This hosiery came greatly into demand and was largely used for over half a century, being a most excellent and durable article. Napoleon's colleague, Consul Lebrun, constructed one of these frames for making fine knotted hose at his stocking factory in France, and in 1795 one thousand frames barely supplied the demand for it in England.

In 1776, Brockley, a poor Nottingham stockinger, devised an imitation of Horton's knotted hosiery; these goods were called twilled, and as they were non-elastic soon passed out of use, but he is said to have "effected an important alteration in the web; which was made with a silk web outwards, by carrying a cotton thread behind, thus making it a double-looped fabric, known as platted work; and so long as the back was of twister *two* threads cotton yarn, the articles wore well." The machines gave employment to

many persons, until the fancy for platted work passed away. Robert Ash patented in 1781, a plan for making "fastened platted work," which was an elastic twilled fabric. In 1790, an improvement on Ash's invention was patented by one Hague. This was called the mesh machine. The goods made on these machines were called elastics. In 1784, Webbe, of Birmingham, patented a simplification of the Derby ribbing frame; three hundred of these machines were worked for some years at Banff with great profit. Rhamboldt took plans of this machine to France where many machines were constructed after it.

In 1788, Holland, a London hosier, obtained a patent for the manufacture of fleecy hosiery vests and drawers, as being medicinally beneficial. In 1790 and 1792, he took out further patents, and his house had a celebrity among medical men and the public at large.

There were no further improvements of any importance up to the year 1800. In spite, however, of the various improvements which had been effected in the stocking frame, wages remained moderate; efforts were made by the Midland Stocking Makers' Mutual Protection Society (which had been formed in 1777) to confine the employment of girl and boy apprentices within proper limits, and they were influential enough to elect a Mr. Abel Smith, as member of the House of Commons for Nottingham, and in 1778 a petition to the House from the frame-workers asking for an act to regulate and settle wages which was voted down. A further reduction being threatened, the bill was again presented and again rejected, which was the signal for riots at Nottingham, frames were broken, homes mobbed, the Riot Act read, and the military called out, and these riots were repeated continually within the next few years.

Trade revived somewhat at the close of the war with the American Colonies, and the wages in the hosiery business increased. At this time, there were in the United Kingdom 20,000 stocking-frames. In 1812, the number of frames had increased to 29,632 in Great Britain and 13,189 on the continent. A demand for knitted hose, underdrawers and gloves for the army, which arose in the early part of the nineteenth century, gave relief to the trade; but it was so small as to be almost ineffectual; the harvests had for several seasons past been bad and "work at any price" was demanded by thousands of suffering knitters, and frames were again broken, one thousand in and around Nottingham alone. Bills for the relief of the stockingers passed the Commons, but were rejected by the Lords, and further riots broke out followed by strikes and by great misery among the stocking weavers; this continued for some years.

An impulse was given to the trade at Leicester by the application of Dawson's eccentric wheels which enabled the manufacturers to produce innumerable articles from stout woolen webs for breeches, pieces and gloves, braces, cravats, and sashes, to the finest and lightest fancy silk or cotton tissues and nets; woolen and cotton socks had begun to be made in

that city in 1810, woolen shirts became an important item there in 1815; and cotton and spun silk drawers and vests at Nottingham, and they have been largely manufactured there up to the present time.

In 1816, Sir M. I. Brunel, whose attention had been drawn to the manufacture of hosiery and lace, so that he was well acquainted with the machinery employed in it, invented a round stocking frame so devised as to employ no one of Lee's instruments except the needle; it embodied Lee's principle, it is true, but was altogether different in construction and use. It is a circular machine, small enough to be attached to a lady's work table, produces a seamless sack; and can make the loops of stockings faster than the eye can follow it, and was destined to become one of the cheapest and most effective looms the world has ever seen. Brunel called his machine the "tricoteur" and was granted a patent for it in 1816. The diameter of the circle round which the needles are placed may be made large enough to knit a circular web of any size, even a carpet. The work is continuous and therefore expeditious, the first row of stitches being made like those in the ordinary knitting frame. From 1825, strenuous and persistent effort had been applied to adjust hosiery machinery so as to be run by rotary hand power. This having been successfully accomplished, the application of steam power followed and the factory system was established. As progressive steps leading to the perfection of the wide frame, the industry is indebted to the machines constructed by Warner, 1829; Mather, 1831; Foote, 1835; Cope, 1836; Coteman, 1837. Luke Barton's and Paget's rotary modifications of the Lee Frame being worthy of especial mention.

The thread carrier, a necessary appliance for increasing the speed of all wide frames was the invention of one of two stocking weavers. Sadlers and Roe; or was possibly the work of both. The course of invention in regard to the knitted goods trade has been arduous and costly, and it is impossible to give in detail the many inventions that have been claimed; we will mention only the more striking modifications. Thornton took out three patents for coarse looped work, which was a very close imitation of hand-knitting, and was continuously in good demand.

The tumbler needle, a most curious and useful invention, was one of several patented by Townsend, who was originally a frame knitter, and then a hosier at Leicester, England, and eventually in the United States, where he was eminently successful. The invention "consisted in affixing on the frame needle a small moving pin, hinged just so far from the hook as that its point may reach the hook, lying in a spoonlike indent; and, when reversed backwards, may lie in a groove, pointing towards the stem of the hook." This instrument is used largely in England, France, Saxony and the United States. In 1854, Hine, and Mundella, with L. Barton, took out a patent for a wide ribbing machine on which ten hose could be made at once, an immense increase in production with a corresponding decrease in labor and expense. One of the first attempts to render the stocking-

frame capable of automatically widening or narrowing as necessity arose was that of F. W. Mowbray, of Leicester.

In 1858, a citizen of the United States, W. C. Gist, took out an English patent for a circular machine, "to be supplied by any number of feeders up to eight," where only one had been worked before. By this means, striped work including sixteen colors may be made at once, and produce on a head of four inches diameter or twelve inches round three hundred and fifty courses a minute. This patent right was purchased by Hine, Mundella & Company, and a modification was at once introduced which rendered Gist's valuable machine simpler and less expensive. Thomas Thompson who (against the adverse claims of Pepper, an American inventor, and Appleton, an Englishman) claimed to be the first to adapt the circular frame so as to produce ribbed work, upon examining Gist's machine, saw the way to improve it by using in lieu of the ordinary needle the tumbler needle, invented by Townsend. This improvement was not patented.

In 1834, an American knitting machine, which had none of Lee's parts in its construction, was introduced into Manchester, England. The frame made ten or twelve hose at once. Very hard twisted durable materials were used on these frames; they were of coarse gauges, and produced excellent imitations of the best hand knit work, being more regular in texture; in 1845, there were six of these frames in operation. These were called "Wild" machines, probably from the name of their inventor.

The McNary Knitting Machine Company, of Williamsburg, Pa., took out English patents for improvements in knitting machines in 1860. These machines knitted at the rate of two pairs of complete stockings in nine minutes. An English patent was taken out in 1863 by Mr. J. G. Wilson, of New York, for an improvement in knitting machines. Since that time hosiery machinery has been greatly improved and modified by various devices and modifications by numerous inventors, both European and American. To Germantown, Pa., the German frauen carried their domestic industry of the hand knitting of woolen hose, and before 1775 there were one hundred and fifty knitting frames at Germantown and in the vicinity of the Brandywine; in 1815 the number of these had increased to two hundred; it is not known when or by whom they were introduced there, and they were probably used mainly in the homes of the operatives, for they do not seem to have formed a part of the cloth and flannel making industries, which early became so prominent in Germantown. Various attempts were made prior to 1818, to encourage the foundation of the knitting industry in various parts of the States; in 1776, the Committee of Safety appropriated three hundred dollars as a bounty to Mr. Coxfender, of Maryland, Frederick County, if he should establish a stocking factory, and we are told that the Society of Arts in New York offered a bounty of ten pounds for the first three stocking-frames of iron set up in that year. Neither of these bounties were claimed.

The British government, with jealous anxiety for the welfare of its textile industries, had prohibited the exportation of stocking machines and a penalty of forty pounds for so doing was in force up to 1780, after that, it was increased from time to time until it amounted to a prohibitory duty. In 1818, the penalty of exporting lace machinery was five hundred pounds, and could this not be paid by the offender, he was subject to several years' transportation. Many of the stockingers and lace weavers who had been deprived of a means of earning their livelihood because of the Luddite riots, determined to come to the United States and bring their tools and implements with them, even though the considerable fines had to be paid.

The first stocking machine which came to New England was smuggled from Liverpool in 1818, and was set up in Watertown, Mass., at a spot near the present Etna Mills; but a part of the machine had been left behind and occasioned some delay in its use until new parts had been made. It was used for a couple of years in Watertown, and was then taken to Ipswich in 1882, by its owners, Benjamin Fewkes and George Warner.

Lace machines were also introduced surreptitiously into the country; the delicate and essential parts of the machine were brought over concealed in the personal effects of workmen who had been employed in Heathcoat's factories, the bulky parts and framework of the machines being made in America from the drawings of skilled machinists, and a factory was established at Watertown, Mass., near the Newton boundary in 1820; in 1824, the machines were removed to Ipswich, and were operated by the Ipswich Lace Company; a rival concern was started in 1828 by the New England Lace Company, of which Dr. Thomas Manning was one of the promoters. This company continued its operations until 1832, when they could no longer obtain a supply of thread fine enough for the manufacture of lace. Up to that time, thread had been exported from England; the British government, finding that machines and workmen had come to this country and that lace was being made here, placed a very heavy export duty on thread, and allowed the free exportation of lace which killed the industry here. The Boston and Ipswich Lace Company closed its doors in 1827; the New England Lace Company, in 1832.

The lace makers being now out of employment, returned to their stocking-frames. Many went to Germantown, Pa., where some imported frames were in use and others to Portsmouth, N. H., while some of the most skillful remained in Ipswich, and in 1832, two new stocking frames were made for Mr. Fewkes, the first made in New England, and perhaps the first made in this country, and he established a stocking factory in a small shop in Ipswich; George Warner, Samuel Hunt, Sr., and Charles Bamford, Sr., each with two machines also began the manufacture of hosiery in the same town. Timothy Bayley, of Albany, it is said, was the first to apply power to the Lee frame in this country in 1831; James and Sanford Peatfield, of Ipswich, had a rotary warp machine in operation in 1834.

"The Newburyport Hose Manufacturing Company" is mentioned in the census report of 1900, as being the only stocking factory in the United States in 1831, and in 1833, there were, as is shown above, four small main factories in Ipswich.

It is almost impossible to give an adequate account of the rise and progress of the industry in this country during the first half of the nineteenth century, owing to the fact that the knit goods before 1850 consisted largely of woolens and there were no separate statistics concerning them. Suffice it to say that in 1850 there were only eighty-five establishments in which knit goods were made, using a capital of $554,735, and producing goods to the amount of $1,028,102. The growth of the industry from these small beginnings during the following fifty years is almost marvellous. The census report for 1900 furnished the following facts: The capital of the combined concerns had increased from $544,735, in 1850 to $81,860,604; the establishments had increased from 85 to 921. In 1900, the total number of spindles engaged in the knitting industry in the United States was: woolen, 293,979; worsted, 21,194; cotton, 206,698; while the knitting machines numbered 690,047. Later official figures show that in 1905 the number of establishments had increased to 1,079, with an aggregate capital of $106,663,531. While the number of spindles employed in the industry was: cotton, 300,037; woolen, 286,661; worsted, 9,664.

The industry in the South is of very recent origin, dating in fact since 1880, when one establishment was reported. In the census of 1900, 71 establishments were reported, with a production to the value of $5,031,-336. Twenty-four of these establishments were in North Carolina; 16 in Georgia; 15 in Virginia; 6 in South Carolina; 4 in Tennessee; 2 in West Virginia; and one each in Alabama, Louisiana, Mississippi and Texas.

The Western States in the same report made a showing of 129 establishments with a production amounting to $12,143,150. With the exception of eleven in Ohio and two in Mississippi, all these factories have been established since 1860. In 1900, Michigan was the most important of the Western group, having thirty-two factories with a production of $2,791,257. Wisconsin was second with twenty-seven establishments, production, $2,486,813. Indiana, which stood sixth in point of establishments and first in capital, was third in value of products. This state had seven factories with a capital of $2,728,306; value of production, $2,242,304. Then came Illinois with fourteen establishments and a production valued at $2,145,429; Ohio had twenty-four factories and the production amounted to $1,576,285. None of the other states in this group reported products valued at over $500,000.

In 1900, the value of the production in this industry in the Middle States amounted to $60,473,407, and in New England $17,834,673, which was over ten times the amount of the production in 1860 and equal to more

than 82 per cent of the total value of these goods produced in the United States. The standing of these States by value of products was as follows:

New York	$35,886,048
Pennsylvania	21,896,063
Massachusetts	6,620,257
Connecticut	4,043,977
Rhode Island	2,713,850
New Hampshire	2,592,829
Vermont	1,834,685
New Jersey	1,784,148
Maryland	514,093
Delaware	429,055
Maine	29,075

The enactment of the tariff of 1910 caused a large importation of automatic machinery for knitting full-fashioned hosiery, that and an increased demand for seamless hose, an American specialty, caused a decrease in the American imports of cotton hosiery, which during the last quarter of 1910 were lower than at any other time during the present century.

Hand knitting is first spoken of in Germany in the middle of the sixteenth century. The art was practised in Berlin in 1590. It is not known when the first stocking loom was taken to Germany. It seems to have been chiefly distributed about that empire by French refugees after the Revocation of the Edict of Nantes; at any rate, they carried to Hesse the first stocking-frames known there; and at Pausa in Saxony, the parts of the machines are called by French names, these frames being brought there from Handee, near Frankfort, shortly after the Revocation. The first stocking-frame was taken there by a man named Becker, who constructed others of wood; Felkin states that looms were made of that material at Olbernheim in the Erzeburge, a district surrounding Chemnitz.

The growth of the hosiery industry in Saxony was very rapid; from 1840 to 1850, the number of looms increased from 20,000 to 30,000; the two centres of the Saxony hosiery manufactured on wooden looms. The industry in Chemnitz was founded in 1728 by three persons, Roeder, Braun and Saur, who transplanted the manufacture of cotton hose, caps and gloves to that place in 1765. In 1802, the guild produced more than 50,000 dozens of hosiery and in 1820 it numbered 1,538 master workmen, 630 journeymen and 346 apprentices.

The firm now trading under the names of Gottlieb Hecker and Soehne, has been established in Chemnitz for nearly 150 years.

Up to a very recent time, one-third of the output of hosiery at Chemnitz came to the United States. But the increased demand in this country for seamless hose, an American specialty, caused a diminution in

the exports, which fell from $1,666,193, in the quarter ending March 31, 1910, to $841,907, in the quarter ended Dec. 31, 1910.

In Saxony, manufacturing methods were more conservative than in England; there was more opposition to new ideas and to new machinery; for instance, wide hand frames with carriers, making several cleared—*i. e.*, fashioned—hose at once were in full employment in England in 1850-1, while in Saxony they did not come into use until about ten years later. Most of the machines brought into use were English. An essential impediment to the quick and general adoption of power machines was the non-development of the machine-building industry.

The production of hosiery in France has attained a high degree of excellence. Troyes may be called the Nottingham of France and is the principal seat of the cotton hosiery fabrication. Nismes and the Department du Gard generally are the centre of the silk industry. In Paris and its environs, most of the fancy goods are made. M. Delarothière of Troyes is one to whom the industry is greatly indebted for many valuable inventions. In 1828, he produced a machine which supplied web equal to that from the English warp frame. His next invention was a machine for making gloves which replaced those which had been smuggled there from England. In 1834, he constructed a device for narrowing stocking feet without seams. Twelve patents were granted him in France in fifteen years and his system of narrowing frames spread over the entire industry in that country. The Poron Frères of Troyes introduced English rotary ribbed frames. M. Tailbuis patented, in 1862, "a rectilinear knitting-frame;" he constructed hosiery machinery after English and French patterns at St. Just, and for his valuable efforts in the fostering and improvement of the knitting industry was awarded the Cross of the Legion of Honor.

MERCERIZATION OF COTTON

BY JOHN H. LORIMER

Mercerization of cotton as now understood and commercially practised differs so much from the mercerization of cotton as described and commercially practised by John Mercer, who in 1850 obtained a patent for his process of treating cotton by immersion in a cold concentrated solution of caustic soda, or caustic potash, that no one familiar with the results obtained then or for over forty years after he made his disclosures would recognize these later results as possible of attainment by the process or processes publicly known and practised by Mercer and other investigators between the years 1844 and 1895.

The fact that Mercer first discovered, patented, and so disclosed a few of the many wonderful effects now produced by the immersion of cotton in a concentrated solution of caustic potash, or caustic soda, no doubt justifies in the popular mind the application of his name to all subsequent discoveries of new effects producible by any modification of his process as described and practised by him and other investigators for over forty years; at the same time it seems to be only fair that specifically new effects obtained by later investigators should be duly acknowledged in any record purporting to give briefly or otherwise a history of the development of the mercerization of cotton.

John Mercer was one of the most notable pioneers of the development of the cotton manufacturing industry of Great Britain, and his process for treating cotton cloth in a concentrated solution of caustic soda or caustic potash was probably his most notable discovery.

His invention as described in his patent application and as further elaborated in the trade and scientific literature of his day was for the double purpose of shrinking openly woven cloths to give them increased strength and closely woven effects and increased affinity for dyes and colors.

Careful investigation of the development of this process of Mercer fails to discover any commercial advance between the results obtained by Mercer at the time of his original disclosures and the disclosures of possible new effects by Thomas and Prevost, in 1895-8, when the new silk lustre effects now so well known were added to those effects previously discovered and disclosed by Mercer.

Horace Arthur Lowe, another distinguished investigator, patented in 1890 what purported to be an improvement of the Mercer process. This

patent of Lowe's seems to have been a natural product of the Mercer process; but as he confined himself to an effort to regulate by mechanical devices the results obtained by Mercer he fell short of the results obtained by subsequent investigators.

Lowe's efforts seem to have begun and ended in the effort to regulate results of Mercer, such regulation to be obtained by mechanical devices and therefore reducible to controllable and commercial limits.

Thomas and Prevost, on the other hand, cut loose from all limitations of Mercer and Lowe and soon discovered an entirely new product previously unknown to either Mercer or Lowe or other investigators, and thus added to the industries of the world a new article of commerce, previously unknown either laboratorically or commercially, and they alone seem to be entitled to the credit of such discovery of the new effects and the new article of commerce known as Mercerized Cotton.

Naturally a discovery of such great commercial value led to disputes as to the validity of patents obtained by Thomas and Prevost, and as such patents as they did obtain very clearly disclosed the fact that the results obtained by Mercer and Lowe formed the basis for their conception of the greater discoveries they had made and which are now known to have been within the grasp of any intelligent investigator with courage enough to begin his investigation of the Mercer process just where Mercer and Lowe left off.

Litigation followed, and because of this litigation a great industrial discovery became public property by "due process of law," which in many instances has become the modern equivalent of the bludgeon of less law-abiding ages.

The story of this celebrated case is replete with the history of the Mercer, Lowe and Thomas and Prevost processes and contains the very best history of the mercerization of cotton obtainable at the present time.

Of course it is too voluminous to be included in this brief story of Mercerized Cotton, but all who seek or require more light on this lustrous subject are referred to the story as contained in the records of the Circuit Court of the United States, District of Massachusetts, Case No. 1458, 1906, where they will find most interestingly told all the historical facts pertaining to the Mercerization of Cotton.

THE SILKY LUSTRE OF MERCERIZATION

BY WILLIAM W. CROSBY

The famous patent suits in regard to the mercerization of cotton developed many interesting questions, among which none was more so than, "What is *silky lustre?*" Whatever Mercer knew more or less than that by means of a caustic soda bath he altered the count of a fabric and its dyeing qualities, it is certain that Horace Arthur Lowe recognized that the question of tension during the caustic treatment was of great importance. Thomas and Prevost in their early patents sought to secure the much desired silky lustre by heavy tension, and their "extra powerful machines" were to stretch the yarn "until the silky lustre appeared." In order to lose no possible advantage they named many reagents to use on the yarn, not only caustic soda and caustic potash, but sulphuric acid, aluminum chloride, zinc chloride, etc. But silky lustre owes its principal properties to a very simple condition. Chevreul long ago described clearly the difference between silky lustre and specular, the latter being that of polished metal, while the former is due to alternated lines of light and shadow, as for instance where light is reflected by a number of polished metal cylinders lying side by side which would throw light from certain elements of the cylinders while the spaces between would be dark.

Textile yarns may be brought into this condition so that when properly spun and twisted there is a close approach to lustre as compared with yarn made of the same fibre but improperly spun and twisted.

When cotton fibres are treated with caustic soda, there is probably but a small chemical change, the cellulose first becoming sodic cellulose, and then hydro-cellulose, but there is a tremendous physical upheaval, for if left free in the bath, the fibres writhe and twist as if alive. If washed and dried, there is a snarly knotted mass which, from the time water is applied, requires a relatively strong force to straighten out; but if at the outset force be used to keep the fibres straight and parallel, it has been shown that this force is only a small fraction of that which will be necessary to straighten them out once they have become snarled. The office, then, of the tension is not so much to produce silky lustre as to prevent the chemicals from destroying that parallelism which makes for the necessary lustre.

It is quite true that a caustic soda bath removes the natural dull surface of the cotton fibre and plumps it out from the collapsed state which is the natural one into a smooth cylindrical state. It has been demonstrated ex-

perimentally that if yarn is so spun that the fibres assume heterogeneous positions, as for instance by spinning them on the woolen system, mercerizing will not make them lustrous. Again in a two-ply yarn, where the doubling and twisting is to the opposite hand from the original spinning, this being the usual way of making the two-ply yarn, upon mercerizing lustre results, while if the doubling and twisting be put to the same hand as the original spinning, even though the mercerizing be carefully done, little if any lustre results. Thus it is to be noted that silky lustre so far as mercerizing is concerned depends concurrently upon a chemical treatment and the spinning of the yarn.

BLEACHING, DYEING AND PRINTING

BY L. DA COSTA WARD

The development of the bleaching, dyeing and tissue-printing industries, in this country, has been so dependent upon what has been done in other countries, particularly in Europe and Great Britain, that in order to give the subject proper treatment we must go back to the earliest times. Precisely when and where the practice of dyeing and bleaching originated will never be known; but from ancient writings we learn that they both flourished many centuries before the Christian era in India, Persia, Egypt, Syria and other eastern countries. That the Egyptians were familiar with the use of indigo is shown by its presence on mummy wrappings preserved in the British and other museums.

Moses speaks of blue, scarlet and purple fabrics, and Job of the colored stuffs made in India and Tyre, and also of washing (the forerunner of bleaching) his clothes in a pit with the herb boreth, which is probably falworth, common in Judea, Arabia and Egypt. Homer also speaks of Nausica and her companions whitening their clothes by stamping them with their feet in a pit.

The dye most particularly referred to by the ancients is Tyrian purple, supposed to have been discovered by the dyers of Tyre. There are many and varied hypotheses regarding the nature of the material employed, but the most generally accepted is that it was the liquor or juice of a certain shell-fish. Many, however, think that this was simply a blind to hide the knowledge of cochineal and a suitable mordant.

The color varied through many tones of purple, and in the time of Augustus Cæsar a pound of wool dyed with this color brought about 1,000 denarii or $160. Moreover, the wearing of "the purple" by any but those of exceedingly high rank was punishable by imprisonment and sometimes death.

The art of dyeing and bleaching became lost to Europe on the fall of the Roman empire, and not until the time of Charlemagne did it again obtain a foothold in Western Europe.

The earliest to become prominent in this line were the Frieslanders, about the beginning of the thirteenth century, and the Hardenwyk dye works are still prominent in Europe. With the outbreak of the Crusades and the resulting contact of Western Europe with the Oriental countries, the taste for colored garments, obtained in the East, was brought to bear

upon the Western manufacturers, who had great difficulty in understanding the Oriental taste. The exact date of the introduction of textile printing into European countries is not known, but it was probably at about this period and undoubtedly had its origin in India. It was not practiced, however, until the seventeenth century, *i. e.,* commercially. At this time, Venice and other republics of the Italian peninsula were leaders in the commerce of the world. Manufactures and dyeing flourished in Venice, Florence and Genoa. Florence possessed about 200 dye houses in the fourteenth century, and from the fact that one of its streets was called "Strada de Roccellarii," Roccella Archil was probably one of the chief dyewoods employed. In 1429 appeared the first collection of dyeing processes ever published. These were printed in Venice under the title "Mariegola dell' Arte dei Tintori" (Manual of the Art of Dyeing), and a second edition appeared in 1510. Giovanni Ventura Rossetti published a similar work called "Plictho dell' Arte dei Tintori" in 1548. The first paper in English on this subject was by Sir William Petty (1623-87) as "An Appendix to the History of the Common Practice of Dyeing," and was printed in the "History of the Royal Society," by Dr. Spratt (1636-1713).

When indigo made its first appearance in Europe is not exactly known, but during the sixteenth century it was used considerably by the Italians and Dutch. It is interesting that the introduction of indigo was strenuously opposed by the cultivators of woad, and at the time of Elizabeth was prohibited in England on the ground that it was a "wicked and pernicious drug," and the act prohibiting its use has never been repealed. Similar steps were taken against the introduction of logwood on the ground of its being poisonous and not at all fast.

By the discovery of America in 1492 and the subsequent numerous explorations, many new dyestuffs were placed at the disposal of the European dyer: notably, logwood, cochineal, annatto and Brazil wood.

The art of bleaching up to this time had not many milestones marking its way to improvement. The ancients were content, from the fact that they knew nothing better, to whiten their garments by steeping in a "lix ivium" made by extracting wood ashes with water, and the early Scotch and Irish similarly used the ashes of seaweed, which they called "Kelp."

Then came the steeping of linen in lyes, with a subsequent souring in sour milk and exposure on the grass for a greater or less period. The time required was from four to six months and was applied to linen only, cotton being deemed sufficiently white.

In 1728, James Adais proposed to the Scotch Board of Manufacturers the establishment of a bleaching field in Galloway. This was accepted, and at the same time $10,000 were offered in premiums for the establishment of similar enterprises in other parts of the country.

The Irish method of using kelp was introduced into Scotland in 1732

by Richard Holden, and resulted in a bleaching field being established at Dundee.

During the middle of the eighteenth century bleaching by the foregoing process was almost a monopoly in the hands of the Dutch, with Harlem as the centre of activity. The bleaching of wool by the fumes resulting from burning sulphur was certainly practiced as early as the latter part of the seventeenth century, but just when this action was first observed the writer has not been able to ascertain.

Such was the condition of the bleaching industry in Europe at that time, and it is very doubtful whether this form of bleaching was conducted at all in America on a commercial scale. The first improvement in this long and necessarily expensive process was that of Dr. Home, of Edinburgh. This consisted in the substitution of a weak solution of sulphuric acid (oil of vitriol) for the sour milk. This reduced the time somewhat, but it still took several months, for as yet no substitute for the "grassing" had been found.

This was the only marked advance in bleaching until Scheele's discovery of chlorine in 1774, of which and its subsequent results we will speak later.

The art of printing textiles was not practiced on a commercial basis in European countries until about the middle of the seventeenth century, and it then consisted solely of block printing. The method consisted in dipping a carved block into a suitably thickened dyestuff solution, and then making an impression of the block upon the fabric to be printed. This necessarily required an enormous amount of time, especially when five or six colors were required. This gave rise to the invention of the perrotine in the middle of the eighteenth century. The perrotine was a block-printing machine, a description of which cannot be made intelligible by writing. Let it suffice to say that it did not meet with general acceptance.

The perrotine gave way to the cylinder printing machine, invented by a Scotchman named Bell, in 1785, and first used successfully in the plant of Messrs. Livesey, Hargreaves, Hull & Co., at Morney, near Preston, England. Cylinder printing is now generally practiced in Europe and America, block printing being still used in India, China, Japan, and in Europe and America only for novelties. (See Plate 10.)

Let us now return to 1774. In this year Scheele, a Swedish chemist, discovered the gas which is named chlorine. He noticed that the cork in the vessel containing the gas turned a very pale yellow, and with that observation dismissed the subject.

In 1785, Berthollet, the distinguished French chemist, published an article on chlorine and pointed to the possibilities of the gas for the bleaching of textiles. During the next two years (1786-1787) James Watt practiced the use of chlorine at the bleaching field of his father-in-law, a man named MacGregor, near Glasgow, and not long after this the

method was used at Aberdeen by Gorden, Barrow & Co., and at Manchester, England, by Thomas Henry.

The chlorine was employed in the form of a solution of the gas in water, and in many cases had disastrous effects upon the work people. Consequently, it fell into disuse until it was found that the gas could be absorbed in alkalies, such as soda and potash lyes, giving efficient bleaching action without injurious effects on the operatives.

The use of chlorine compounds revolutionized the cotton and linen bleaching industry, reducing the time required from four months to two days.

In 1798, Charles Tennant, of Glasgow, took out a patent for the use of chlorine absorbed in lime water; but the patent was nullified on the grounds that it included the use of lime for "bucking," as the preliminary treatment with alkaline liquors was termed. Although lime had been used previous to this time, it was in an entirely different manner.

In 1799 (April 13), Tennant was granted a patent for the preparation of solid "chloride of lime" or "bleaching powder," the process consisting in saturating slaked lime with chlorine gas.

Until today, this is still the most important compound employed in the bleaching of vegetable fibres.

Let us now turn to America. In the earlier days of colonization, from the nature of things, much time could not be spent in the development of manufactures. However, as the questions of safety and government became less urgent, the minds of the people turned to the production of clothing, household articles, etc., which hitherto had to be obtained in the greater part from the mother country.

The colonial policy of England did not coincide, however, with the desire of the colonies to enter the manufacturing field. The English view of the situation is expressed as follows: "The original intent of planting those colonies, viz., to be a benefit to their mother country, to which they owe their being and protection." Lord Sheffield said that "the only use" of the colonies was a monopoly of their trade; and Lord Chatham declared that "the British colonists of North America had *no right* to manufacture even a nail or a horseshoe."

The English policy was to keep the colonies in a state of dependence upon the mother country for their clothing, tools, furniture and all other manufactured articles. A law passed in Virginia, in 1684, to encourage textile manufactures, was promptly annulled in England, and in 1731 the carriage of woolens and hats from one colony to another was prohibited by law. The colonies must buy everything from England and sell only to England. In consequence of this, they were compelled to buy more than they could sell, and by 1771 they were practically in a state of financial ruin. The effect of the English policy was that many of the colonists took to wearing leather garments for the reason that they couldn't afford to buy woolens.

The women wore leather underskirts, and, with the exception of the sheets, bedding consisted almost solely of leather and furs. The women gradually learned to spin and weave, and, as public manufacture was prohibited, these operations were usually carried out in private households.

In 1765, a society was formed in New York to encourage the manufacture of woolens, and homespun cloths became the fashion. It is at this time that the first mention of dyeing in America occurs, and although no names or dates are given, it is stated that each village had its own dyer and fuller. The colors were poor and nearly all ran. This would serve to indicate that those employed in this branch were novices, as there were plenty of fast colors known to the initiated. This is one of the reasons why the Continental Army presented such a bedraggled appearance during the Revolutionary War.

In 1774, a linen printing establishment was started in Philadelphia by John Walters and Thomas Bedwell, with the announcement that "a single gown may be printed, waistcoats, chair-bottoms, etc., in durable colors."

As a result of the War of Independence, factories began to gradually spring up all over the country, but they were necessarily small and far apart, on account of the poverty of the nation. In 1779, John Hewson and a man named Long started a linen and calico-printing plant in Philadelphia, and in 1789, with a loan of 200 pounds from the state, were able "to enlarge and carry on the business of calico printing and bleaching within the state" (Pennsylvania). "General Washington was accustomed to point with pride to the domestic fabrics on the person of Mrs. Washington, from the establishment of Mr. Hewson."

The first mention of cotton manufacture refers to a mill established at Beverly, Mass., in 1787, but it is highly probable that bleaching and dyeing were not carried on in connection with it.

In 1789, the Manufacturing Committee of Pennsylvania held its first sale of printed cottons, etc., and John Hewson was elected printer to the society, and in this year the first plea was made for a protective tariff.

About the middle of the eighteenth century a Turkey-red dye works was established at Rouen, France, by a company of Greeks, and in 1765 the French government caused the method of operation to be published. Toward the end of the eighteenth century a Turkey-red dyehouse was established at Manchester, England, by a M. Borelle. In 1783, a Frenchman named Papillon established a similar plant at Glasgow, and Mr. Wilson, of Ainsworth, established one at Manchester, having obtained the process from the Greeks of Smyrna. Papillon was employed by Messrs. David Dale and George McIntosh, and their successors have carried on the business for more than three-fourths of a century. In 1803, the process was made public, and gradually passed into other countries. The exact date of its introduction to America is doubtful, but was probably between 1815 and

1. Primitive Hand Printing 2. Filling in. 3. Printing, Twelve Colors.

JAMES H LAMB Co.

1820. This method seemed only applicable to cotton yarn, but in 1810 cloth itself was first successfully dyed with this color at the works of Messrs. Koechlin, in Mulhausen, Germany.

In 1775, Edwin Bancroft made public the dyeing value of quercitron, and obtained from the Parliament of England the exclusive right to its importation for six years. The use of madder, which, before the introduction of alizarin, in 1868, was a most valuable dyestuff, appears to be very ancient, having been employed by the ancient Egyptians, Hindoos and Persians. Its first European cultivation was probably in Spain, having been introduced by the Saracens. It was grown in Marseilles in 1287, but not extensively until about 1660-70. Madder cultivation in England was never very successful, although it was attempted in 1624 and later in 1670, premiums having been offered by the London Society of Arts to encourage its growth.

In 1791, the General Assembly of Connecticut granted permission to a man named Fitch to build a dam and mill at Stamford. Shortly after this the property changed hands, and in 1796 the new owners started cutting and grinding logwood. A few years later they began to make logwood extract, and about 1800 built a new mill nearby the old one. In 1844, the business was incorporated under the laws of Connecticut as the Stamford Manufacturing Company, which name it still retains. This is the earliest record the writer has been able to obtain in reference to dyestuff manufacture in this country.

In the year 1803 a calico printing plant was established in Germantown, Pa., by a man named Stewart, and another in the same year by Thorbourne, at Darby, Pa.

In order to acquire some idea of the extent of cotton spinning in the United States at the beginning of the nineteenth century, and which naturally had a promising influence on the dyeing, bleaching and printing industries, we find: In 1804 there were four cotton mills in successful operation; in 1807 there were fifteen; in 1811 there were eighty-seven. In 1815 Rhode Island was the centre of the industry, and between 1806 and 1814 Massachusetts had granted charters to fifty cotton mills. In 1813 New York chartered fifteen and there were five in Paterson, N. J., and eleven in Baltimore, Md.; yet up to this time the cloth was made at home on hand looms.

The production of more material increased the demand for bleached and colored fabrics and resulted in the increase of the number of bleacheries, dyehouses and print shops.

George S. White, in his "Memoirs of Samuel Slater," states that "bleaching, calenderings, etc., were introduced at great expense, in Providence, by Dr. Bowen, where the water is well adapted, and there is now (1836) a bleaching and beetling establishment called by his name. The bleaching business is now very extensive in the United States and they are

becoming more perfect in process, as more attention is paid to every department in preparation for calico printing. Rhode Island appears to be in advance in the bleaching business, both for quality and quantity of its work."

In 1809, Messrs. Thorp, Siddall & Co. established a print and bleach works between Germantown and Branchtown, Pa., on the cylinder-printing system which had been invented by Bell. In this year Siddall brought machinery and engraved rollers from England, and in October of the following year (1810) the first lot of calico printed by the new system was put upon the market at Philadelphia.

The year previous to the establishment of the Thorp, Siddall Co., *i. e.*, 1808, the process of engraving the copper print rollers by means of a die was invented in England by Jacob Perkins and introduced the same year by Joseph Lockett, who was engraver to the calico printers of Manchester, England.

The new printing process was considered wonderful. One man and two boys were able to print 10,000 yards of cloth and 50,000 handkerchiefs in a single day.

Two or three years after this, about 1812-13, cotton and linen goods were first dyed in the piece for various uses. In 1809, James Madison wore a black broadcloth suit made and dyed in this country. In June, 1810, Benjamin, Charles, Elisha and Olney Dyer, together with Charles Warburton, "an experienced workman from England," formed a joint stock partnership, under the firm name of the Providence Dyehouse Company, at Providence, R. I. They did a business in dyeing yarns, accepting their pay entirely in yarn, which yarn they afterward put out to weave, giving "great encouragement for weaving fine numbers." (See sketch of Providence Dyeing and Bleaching Company.)

In the year 1811, Hercules Whitney and Henry Hoppin bought from the widow of William Smith, an Englishman, the patent rights to a friction calender, dated 1805, and did business under the firm name of Whitney & Hoppin. In 1815, together with James B. Mason, Benjamin and Charles Dyer, Benjamin and Thomas C. Hoppin, they formed the Patent Calendering and Bleaching Company, buying in also a patent on a press. In the year 1814 Whitney & Hoppin had, with Edward Mason, Jr., and Daniel Bates, purchased from Oliver Evans, of Philadelphia, a Columbia steam engine for running their finishing works, and in December, 1815, the two companies were amalgamated as the Providence Dyeing, Bleaching and Calendering Company, with the addition of Smith Bosworth as a partner, he becoming the first agent of the company. The company is still in existence (1911), and has a complete record of its stockholders from 1815 and the original partnership agreements of all three companies and also the permit from Oliver Evans to run his engine, which is a record of great interest and merit.

In the year 1816 Messrs. Reynolds and Innis made dyestuffs (undoubtedly grinding of woods and preparation of extracts is meant) at Poughkeepsie, New York, being the second firm on record in this particular line.

During the later years of the eighteenth and the beginning of the nineteenth century, Samuel Wetherill carried on the art of dyeing of woolen goods, also fulling and and chemical manufacture in South Alley, Philadelphia, and laid the way for the present white lead manufactory controlled by his descendants. After the War of 1812, fresh impulse was given to manufactures of all kinds, and in 1820 the Boston Manufacturing Company established a bleaching and dye works at Waltham, Mass., which continued under that name until 1901, when the name was changed to the Waltham Bleachery and Dye Works.

In 1823, James Bolton, Samuel Pilling and Peter H. Schenk, of Bronxdale, New York, established a dyeing, bleaching, printing and finishing plant at this place, which is still in existence (1911), being known as the Bronx Company, New York City, having from the time of its organization been a family concern.

In 1826, the Hudson Calico Printing Works of Marshall, Carville and Taylor were established at Stockport, N. Y., with one machine, small dyehouse and bleach-house, and other necessaries for finishing. They printed 300 yards per day, and carried on both block and cylinder printing. In 1836, they had three printing machines made in England, a dyewood grinding mill and a madder dyehouse 286x50 feet, the largest of its kind ever built, and at this time employed 200 men.

In 1827, the Cocheco Manufacturing Company was incorporated by John Wheeler, Moses Paul, Matthew Bridge, George Bond, Ed Bourne, Patrick T. Jackson, Edward H. Robbins, Jr., and Samuel Torrey as a print works. In 1909, the plant, then consisting of cotton mills, print works and a velvet mill, was absorbed by the Pacific Mills, of Lawrence, Mass.

Bleaching by manual labor was carried on until 1828, when Mr. Bentley, of Pendleton, England, attempted to introduce machinery to take its place. Mr. John Graham, of England, also did much to bring the bleaching process to its present state.

In 1829, Thomas Hunter began the practice of calico printing in Philadelphia, and in 1832 he started the operation of a copper roller machine, the roller having been engraved by Matthias Baldwin, of locomotive fame. Baldwin became associated with David H. Mason in 1825, when they formed a partnership for the purpose of engraving rollers for calico printers, and were the first to carry on this art in America. They soon increased their business, and started the manufacture of printing machines and drying calenders for wool, cotton and silk materials. On

Thomas Hunter's death in 1848, he was succeeded by his sons, John and James.

Watson, in his "Annals of Philadelphia," states that in this city in 1827, $228,000 worth of indigo was used and that there were about 200 dyers who received on the average of $5.00 per week in wages.

In 1830, the plant known as the Allen Printing Company was founded by Governor Philip Allen. From 1901 to 1907 the plant was leased to a private company and later went into the hands of Jesse Metcalf Company, of Providence, R. I., and so passed out of existence as a bleachery.

In 1831, Joseph Bancroft started the manufacture of cotton goods at Wilmington, Del., and some years later, the exact date not being known, the dyeing and finishing end of the business was established and is still flourishing. In this year (1831), according to the Memoirs of Samuel Slater, the printing of calico in this country was greatly improved.

On the 13th of January, 1833, the State of Massachusetts granted a charter "that Jonathan Derby, John Clark and Augustus H. Fiske, their associates, successors and assigns be and they hereby are made a corporation by the name of the 'Lowell Bleachery,' for the purpose of bleaching, coloring, printing and finishing cotton and woolen goods, etc." The original capital was $25,000, which was gradually increased to $400,000 and afterward reduced to $200,000; in 1911 is still doing business under the original charter.

Browning & Bros., in 1834, started the manufacture of dyewood extracts in Philadelphia, being probably the first in this locality to follow this work, and in the same year the American Printing Company was established by Holder, Borden and others at Fall River, Mass., with four machines and a weekly output of 2,000 pieces. The plant was gradually increased, and in 1880 M. C. D. Borden bought the property of the Fall River Iron Works and used the liberal charter for the consolidation of several large cotton mills. Mr. M. C. D. Borden, by purchase, became the sole owner of the American Printing Co. in 1886, which, taken together with the above-mentioned mills, is said to be the largest manufacturing plant under one ownership and management in the world, and at the present day the printworks print about 600 miles of cloth per day and put upon the market some 3,000 new patterns each year.

In the year 1834 John Large established the Summerdale Print Works, and in 1836 the country boasted the following bleacheries: Ten or twelve in Pennsylvania; Phillip Allen's, at Providence, R. I.; Sprague's, at Cranston, R. I.; Crawford Allen's, at Pawtucket, R. I.; one at Lowell, Mass. (Lowell Bleachery); one at Taunton, Mass.; one at Dover, N. H.; two at East Madden (probably R. I.); two or three in New Jersey.

The bleaching was generally carried on in connection with calico printing, and the year ending April, 1836, shows a record of 120,000,000 yards printed.

The so-called "American Process" of calico bleaching was introduced in 1837, though just why it is given this name is not very clear. It consisted of the following operations, which are still followed, with minor changes, to this day:

(a) Singeing. (b) Gray washing. (c) Boiling with lime, under pressure. (d) Treatment with weak acid (gray sour). (e) Boiling with resin soap, under pressure. (f) Boiling with soda ash, under pressure. (g) Treatment with bleaching powder solution (chemick). (h) Treatment with weak acid (white sour). (i) Rinsing in clean water. (j) Drying.

It was in this year (1837) that Smith Gray founded what is at present known as the S. Gray Company, at Walpole, Mass.—for the purpose of bleaching and dyeing cotton yarns and thread—with an original production of 1,000 pounds per day. This has increased to 10,000 pounds per day.

The first manufacture of bleaching powder in this country was conducted at Bridesburg, Pa., by Charles Lennig, in 1847. The production of this substance has increased enormously, and in 1898 the Dow Chemical Company at Midland, Mich., and the Mathieson Alkali Works at Niagara Falls, N. Y., began its manufacture from electrolitic chlorine. It is, however, still imported in large quantities, the amount in 1900 being 136,403,151 pounds, valued at $1,464,019.

In the year 1847, also, Elijah Upton and T. W. Walker established the Danvers Bleachery and Dye Works at Peabody, Mass., then known as South Danvers. This plant was in operation under the old name as late as 1908-1909. It has, however, recently been absorbed by the Naumkeag Co., of Salem, Mass.

In the following year, that is, 1848, William Simpson, Sr., established a bleaching and calico printing plant at Falls of Schuylkill, Pa., and in 1876 the plant was transferred to its present location at Eddystone, Pa., and became known as The Eddystone Manufacturing Company, and at present is one of the largest plants of its kind in this country. In 1849 we find another pioneer in the dyestuff field in Alexander Cochrane, who started to make indigo extract at Lowell, Mass., and in 1850 W. P. Uhlinger, of Philadelphia, began the manufacture of hydroextractors. Also, in 1850, the Eagle Mills were established in Columbus, Ga., and from the outset did their own dyeing and bleaching. During the Civil War these mills were operated by the Confederate government for the manufacture of uniforms, and in 1865 were burned by General Wilson, of the Federal Army, after the Battle of Columbus, on the ground that they were Confederate property. During the period of reconstruction, the mills were re-built (1866-67), and from the nature of their previous destruction and reorganization were named the Eagle and Phenix Mills. It may be of interest to state that these were the first cotton mills in the world to be completely lighted by electricity. In 1852 The Tolhurst Machine Works were established at Troy, N. Y., and built their first old-style under-driven hydro-

extractor in October of 1878. This machine was termed self-balancing. In 1885 William H. Tolhurst was granted a patent right on the "Tolhurst Self-Balancing Extractor."

During the early 50's delaines were being largely imported, and constituted one of the chief forms of low-grade dress goods. In 1854 the Pacific Mills, of Lawrence, Mass., first put their products on the market, and at that time, under a low tariff, English printed calicos and delaines came into keen competition with the home product, causing a sharp conflict for the control of the market, which resulted in a victory for the American manufacturer.

From the earliest time, up to the year 1856, dyers and printers were limited to the colors derived from minerals, woods and certain insects. In 1856 Sir William H. Perkin discovered that a violet coloring matter could be made artificially from aniline, which is one of the products derived from coal tar. This he called Mauveine or Perkin's Violet. This discovery was destined to revolutionize the whole dyeing industry, and other discoveries followed each other in amazing rapidity, of which we will give a brief account later.

In 1858 or 1860 Chas. G. Sargent began the building of his drying machines for raw stock. These were platform or table dryers, and Mr. Sargent had a patent for blowing air, hot or cold, up and down through the stock on the screen. This patent made a very broad claim and covered practically the whole principle.

Later the Sargents conceived the idea of building a drier in which the stock could travel from one end of the machine to the other, and in 1883 Mr. F. G. Sargent conceived the idea of a travelling wire cloth belt for conveying the material through the chamber while being acted upon by a circulating current of heated air.

This was the beginning of the Sargent Automatic Dryer, which, in 1892, was changed from a one-apron to a five-apron dryer. Five aprons being found unnecessary in 1895, the three-apron dryer was adopted.

With the outbreak of the Civil War, the cotton industry in the United States was sadly affected, owing to the cutting off of the supply of raw material; but the woolen industry received great impetus, owing to large government orders. So great were these that many cotton mills undertook the manufacture of woolen materials.

Harvey and Oliver Arnold, however, reversed the old adage "in time of war prepare for peace." In 1862 they built a print works at North Adams, Mass., trading as Harvey Arnold & Co. In 1876 a new company, including the two Arnolds, was incorporated as the Arnold Print Works and their products are known throughout the country.

Like the Arnolds, Richard Greenwood and William Bault established a dye and bleach works at Philadelphia in 1864, and are now doing business under the name of the Globe Dye Works Co.

In 1867 John H. Foster and the late Thomas Firth established a dye house in Philadelphia which gradually increased until, at the present day, it is, in the estimation of many, the largest of its kind in that city. In the following year (1868) the Newburgh Bleachery was established at Newburgh, N. Y., and in 1869 Forsyth and Fisher established the Elm City Dye Works at Westville, near New Haven, Conn., which concern, after several changes, became the Pond Lily Co., the Forsyth family having always been in connection with the plant.

It was in the latter part of the 60's that the coal tar colors began to come into this country, and in 1871 Messrs. Wm. Pickhardt and Kuttroff introduced the products of the Badische Anilin-und Soda Fabrik, of Ludwigschafen, Germany, and at about the same time Messrs. Rumpf and Lutz imported the products of Meister, Lucius and Brunnig, of Hoecst, Germany.

In 1872 Spencer Borden started the Fall River Bleachery, at Fall River, Mass., which has since quadrupled in size, and in the same year Jacob Weidmann established a silk dyeing plant at Paterson, N. J., which is now (in 1911) the largest plant in the world, dyeing skein silk exclusively.

In 1875 A. Klipstein first imported dyestuffs made by Bindschedler and Busch, of Basle, Switzerland, who later combined with other factories and took the name of the Society of Chemical Industry in Basle.

The following year, 1876, Mr. William J. Matheson became the American agent for the products of Leopold Cassella and Co., of Frankfort, Germany, and introduced their products to American dyers.

Turkey red oil, well known to all dyers and printers of cotton goods, was manufactured in this country as early as 1876 by the Walpole Dye and Chemical Works, at Walpole, Mass. Mr. Lane, of the firm of Bosson and Lane, was then superintendent of the works, and recalls the old method which consisted in using five-gallon crocks, a large number of which were required to get out much of a production. Each crock was surrounded by circulating cold water to prevent too great a rise in temperature during the process. It often happened, however, that, even with the greatest care, much of the product would be spoiled. Messrs. Bosson and Lane state that they now produce batches of 300 gallons, and, by exercising great care, have comparatively little trouble in maintaining uniform quality. Mr. Lane states that he thinks the Walpole product was the first marketed, though many old Scotch dyers claimed to have made Turkey red oil in this country for their own use before it became an article of trade.

On the 7th of February, 1877, Edward E. Poor, Chas. A. Denny, James L. Morgan, James L. Morgan, Jr., John M. Goetchins, Edward L. Kalbfleisch, George P. Slade and T. Morgan Slade organized the Passaic Print Works at Passaic, N. J. Mr. Poor was the moving spirit from its inception. and was still associated with it until his death in 1900. The present treasurer (1910), Edward E. Poor, was Mr. Poor's oldest son.

In 1878 The Actien-Gesellschaft fur Anilin Fabrikation, of Berlin,

Germany, introduced their dyestuffs into the United States, Messrs. Henry A. Gould & Co., of New York City, being their agents. Later, the Boston Dyewood Company took the agency, and later the New York and Boston Dyewood Company, which is now the American Dyewood Company. Since March, 1899, however, these products have been handled by the Berlin Aniline Works.

One of the first, and by far the largest manufacturers of artificial dyestuffs in this country, is the Q. V. Schoellkopf, Hartford & Hanna Company. The works were established in 1879 by the late Jacob F. Schoellkopf, his sons, Jacob F., Jr., and C. P. Hugo Schoellkopf, at Buffalo, N. Y., as the Buffalo Aniline Works, the object being the manufacture of coal tar dyes and intermediate products to serve as raw materials for other industries.

At this time peroxide bleaching was just coming before the public, and the first to manufacture hydrogen peroxide in this country was the Oakdale Chemical Company in 1881. The chief drawback to the new bleach was its price, and it was but little used, although its value as a bleaching agent was realized until the introduction of sodium peroxide, of which we will speak later. In this year W. H. Lorimer Sons Co. established in Philadelphia, Pa., a dyeing, bleaching and mercerizing plant. In 1882 Kalle & Co., A. G., dyestuff manufacturers, of Biebrick, Germany, became represented in this country by Messrs. Herlein & Kupferberg, and in 1883 their representatives were Messrs. Leisel and Holbach, which firm became Leisel and Georgi in the latter part of the same year. In 1884 Kalle & Co. became established in this country under their own name.

Previous to 1882 the products of the St. Denis Dyestuff and Chemical Company, of Paris, France, were handled in this country by A. Porrier. In that year A. Porrier and G. Dalsace consolidated, forming the St. Denis Co., with Mr. W. J. Miller as the representative in charge. Previous to the consolidation, Mr. Porrier was represented in New York by Mr. John D. Wade; in Philadelphia, by Messrs. Andreykovicz and Dunk, and in Boston by the Boston Dyewood Co. In 1884 Mr. Walter F. Sykes succeeded Mr. Miller, and has since held the sole agency in this country for the St. Denis products.

In this year Ludwig Sjöström established a dyeing plant at Lawrence, Mass., in a small wooden building with 1,800 square feet of floor space, from which has grown the Lawrence Dye Works Company, with, in the year 1911, two and one-half acres of floor space. This company claims to be the only one in the country capable of handling practically all classes of textile fabrics, yarn, slubbing and rawstock, in the bleaching, dyeing, printing and finishing processes, the capacity being four to five million yards of cloth and two million pounds of yarn or rawstock per annum. This is surely progress.

In 1885 Messrs. Mather & Platt, Ltd., of Manchester, England, introduced their "Mather Patent Kier" for the boiling out and bleaching of cot-

ton cloth. Three were put in use the first year, and in 1901 there were sixteen in operation in the United States. By this invention, the time of changing three and one-third tons of cloth in a particular operation was reduced from several hours to ten minutes. Until 1897 these kiers were made to stand fifteen pounds pressure per square inch, but since then they have been built to work at forty pounds pressure per square inch.

In 1886 The Auger and Simon Dyeing Co. was established at Paterson, N. J., as a silk dyeing plant, and in the same year Leonard Weldon, of Amsterdam, N. Y., put upon the market a machine of peculiar design for the dyeing of yarn, and a similar machine was marketed two years later by Klauder Bros., of Philadelphia. In 1890 a consolidation took place, and the Klauder-Weldon Dyeing Machine Company was formed. Many other firms make dyeing machines, but this one is mentioned for the reason that it was one of the first and also because of its peculiar style and general applicability.

Up to the present date there have been approximately 3,092 patents taken out in the United States for processes and machines for bleaching and dyeing, printed copies of these patent papers being valued at $154.60. Needless to say, we will not go deeper into this subject.

We have referred above to the introduction of peroxide bleaching and its chief drawback. Hamilton Y. Castner discovered a practical process for the production of sodium peroxide on a large scale, and patented the same in April, 1893. From that time, until 1896, this article was imported from England, where it was being manufactured; but, in that year, the Niagara Electro-Chemical Company had finished a factory at Niagara Falls for the manufacture of sodium peroxide under Castner's patent. Thereafter it could be sold at a much lower price, and, as a consequence, the price of hydrogen peroxide was considerably reduced also, so that, from 1896 on, bleaching with peroxides assumed commercial importance. In June, 1899, five dyeing, bleaching and finishing plants were incorporated as the United States Finishing Company; the various plants and their dates of establishment being as follows:

Pawtucket Branch	1836
Norwich "	1840
Silver Spring "	1864
Passaic "	1869
Sterling "	1880

Another product which has been advocated especially for the dyeing of acid colors is formic acid. The first importation of this acid for commercial use was made on January 20, 1902, but time alone will tell how far it will replace sulphuric or acetic acids for this purpose.

To even mention the plants of more recent establishment would neces-

sitate more space than the writer is permitted to use for this article, and many firms who are adding to the history of bleaching, dyeing and printing of textiles, and by their brains and energies bettering their respective branches, and who have been courteous enough to give me information regarding their origin, must pass unnoticed for this reason.

The introduction of coal tar colors has done so much for the advancement of the dyeing and printing of textiles that a brief chronological account of the growth of the industry will not be out of place at this point.

As early as 1771 Woulfe prepared picric acid from indigo and nitric acid, and in 1834 Runge discovered aurin. Neither of these were made commercially, however, at this time on account of the cost of the materials.

1856—Mauveine discovered by Sir. Wm. H. Perkin.

1857—Mauveine manufactured by Sir W. H. Perkin & Sons at Greensford Green, near London.

1858—Magenta discovered by Natanson.

1859—Magenta manufactured by Verguin, in connection with Renard Bros., at Lyons, France.

1860—Rosaniline blue discovered by Girard and de Laire, of France.

1861—Methyl violet discovered by Lauth.
Phosphine discovered by Nicholson.

1862—Water or Nicholson's blue discovered by Nicholson.
First artificial green dye discovered by Cherpin. Called aldehyde green.

1863—Hoffman's violet discovered by Hoffman.
Aniline black discovered by Lightfoot.

1864—Martius yellow discovered.

1865—Bismarck brown discovered by Martius.

1866—Methyl violet made commercially by Lauth and Ch. Bardy.
Iodine green discovered by Kiesser and replaced aldehyde green.
Bismarck brown manufactured.

1867—Methyl violet made by Poirrier and Chappat and replaced Hoffman's violet.
First soluble Induline prepared by Coupier.

1868—Magdala red discovered by Clavel.
Alizarine prepared by Graebe & Lieberman.

1869—Alizarine manufactured by Graebe, Lieberman & Perkin.
Gallein and Ceruleine discovered by Baeyer.

1873—Methyl green discovered by Wischin and replaced iodine green.
Cachou de laval; first sulphur dye prepared by Croissant and Brettonière.

1874—Eosines introduced by the Badische Anilin u. Soda Fabrik.

1875—Alizarine orange introduced by the Badische Company.
Chrysoidine discovered by Caro.

1876—Chrysoidine manufactured by Williams, Thomas & Dover, of England.
Orange, No. 1 and No. 2, discovered by Roussin.
Griess and Witt independently prepared the Tropæolines.
1877—Orange, No. 1 and No. 2, manufactured by A. Poirrier at Paris.
1877—Lancaster yellow discovered by Griess and manufactured by Joseph Story of England.
Methylene blue introduced by the Badische Company.
1878—Fast red A discovered by Caro.
Alizarine blue and Malachite green also introduced.
Ponceaux and Bordeaux introduced by Meister, Lucius and Brunnig, of Germany.
1879—Napthol yellow S discovered by Caro.
Biebrick scarlet discovered by Nietzki.
1880—Baeyer completed his synthesis of indigo.
1881—Resorcin brown discovered by Wallach.
1882—Alizarin blue S introduced.
1883—Carbonyl chloride first used in dyestuff manufacture by Caro and Kern, resulting in discovery of Crystal violet.
1884—Congo red the first direct dyeing cotton color put upon the market. Discovered by Paul Bottiger the year previous.
1885—Naphthol black, the first satisfactory azo black prepared by Hoffman & Weinberg, of Germany.
1887—Primuline, the first developed cotton dye, discovered by Green.
Acid magenta and acid violets discovered by Caro.
Alizarine black introduced by the Badische Company.
1888—The Oxazines and Rhodindulines introduced by Fischer and Hepp.
Alizarin green introduced by the Badische Company.
1889—Gans discovered Diamine black RO, the first direct cotton black, which was followed by the Columbia blacks.
Diamond black discovered by Baeyer and which was the first after-chromed black.
Formaldehyde applied to the preparation of dyes by Meister, Lucius and Brunnig, resulting in New Fuchsine, the acridine and pyronine dyestuffs.
1890—Heumann's synthesis of indigo.
1891—Hoffman & Daimler prepared the first direct dyeing cotton green —namely, Diamine green.
1894—Oxamine dyes introduced.
1896—Vidal black, and the commencement of the sulphur dye industry.
1897—Indigo made commercially by Heumann's process by the Badische Company.
1901—First of the Indanthrene dyes introduced.

Sulphur colors have gained great importance since 1896, when Vidal published his process, and are now manufactured by nearly all dyestuff establishments. Since the beginning of the twentieth century many valuable colors have been put upon the market, among which may be mentioned the Algole colors, the Helindone colors, the Acid Alizarines, the Anthracene Chromate and the Ciba colors.

In the last twenty years various types of machines have been devised for the dyeing of rawstock, yarn, cops, tops, etc., most of them based, however, upon the same principle—namely, keeping the material stationary and circulating the liquor, either by pressure or by partial vacuum, and Messrs. Jackson and Hunt, of England, have patented a kier by means of which cotton cloth may be passed through the various bleaching operations in the open width.

Perhaps the greatest benefit derived from the development of the dyestuff industry is the calculation of dyes and dyewares on the percentage basis, all amounts being reckoned as a certain percentage of the weight of the material to be dyed. The old methods of "Bucket and Scoop" have passed away, except in a few old-fashioned establishments.

The bleaching, dyeing and printing of textiles in America have developed remarkably in the last century, but though the number of establishments and the quality of the production have greatly increased all the great improvements in processes, the discovery of new classes of dyestuffs and their modes of application are of foreign origin.

To Germany, in particular, are we indebted for most of the dyeing processes in use for artificial colors. To England we are indebted for bleaching powder, the first artificial dyestuff, and for the roller printing machine, and to France for the first sulphur dye.

There are many reasons for this, among which may be mentioned the high price of alcohol in the United States, large amounts of which are necessary for the manufacture of dyestuffs, and the comparatively recent realization by the textile trade of the value of the chemist.

A comprehensive view of our growth in the bleaching, dyeing and printing of textiles may be had from the following:

INDEPENDENT DYEING AND FINISHING PLANTS.

Year.	No. Establishments.	Capital.
1850	104	$4,818,350
1860	124	5,718,671
1870	292	18,374,503
1880	191	26,223,981
1890	248	38,450,800
1900	298	60,643,104
1905	360	88,708,576

Chemicals and Dyewares used in all Textile Industries, 1890-1905.

	1890.	1900.	1905.
Independent Estimates	$8,407,693	$10,667,621	$10,587,319
Gen. Tex. Estab	11,278,970	14,724,952	16,095,300
Total	$19,686,663	$25,392,573	$26,682,619
Cotton	$4,266,773	$5,718,107	$4,573,375
Wool and Worsted	5,889,612	7,983,684	9,177,681
Hosiery and Knit	564,053	1,023,161	1,677,252
Silk	558,532	....	666,992

Figures taken from U. S. Census, 1905.

The United States, however, is still a very young country, and we look forward to as great a development in the preparation, coloring and printing of textiles as there has been in many of the other important industries of our country.

HISTORY OF THE DYESTUFF AND DYEING INDUSTRIES

BY HERMAN A. METZ

In the consideration of the history of the development of the art of dyeing and the growth of the dyestuff trade and industry, we find the subject naturally divides itself into three parts in which the conditions differ widely. These eras may be called:

I. The Era of Localized Dyeing.
II. The Era of Exploitation of Natural Coloring Matters.
III. The Era of Synthetic Dyestuffs.

The first era comprises the whole historical account of the subject previous to the development of foreign commerce, succeeding the discovery of America in 1492. During this period, so far as we know, the methods of coloring textile fabrics, as well as the composition of the fabrics themselves, was limited by the local conditions—that is, to such dyestuffs as were conveniently at hand, for it was impossible to transport the raw materials any distance, and, therefore, whatever coloring matters or dyestuffs were at hand were used.

This condition caused some of the most pronounced and brilliant shades to be called by the geographical names of the localities where produced, as, owing to the lack of dyestuffs or other necessary material, they could not be produced in other localities.

Some of the names are still in vogue at the present time. How many people using the term "Turkey Red" think that it has any relation to the country at the eastern end of Europe, and that originally all of it was dyed there. Tyrian Purple is another, this color being dyed from the coloring matter from shell fish found on the shore of the Mediterranean Sea. The name "Indigo" has a more remote descent from India, but the connection is the same, all these being brilliant colors produced in some far-off country and imported at great cost.

II. **The Era of Exploitation of Natural Dyestuffs.**—In the century immediately following the discovery of America, foreign commerce by means of ocean vessels was most successfully developed, and communication established between countries before either unknown or seldom visited. This led to the exchange of products, and what effect this had on the manufacturing industries of Europe can be seen both in the legislation of the time and the country of origin of many of the raw materials. When the importation of the new, foreign dyeing materials began to affect local

industries, relief was sought by legislation, and the importation of both indigo and logwood was prohibited in England.

In furnishing a supply of new materials the then recently discovered Americas were probably the most important source. During the time covered by this period, America had furnished logwood, originally campeche wood, the most important of the natural dyewoods, Brazil wood and peachwood of the redwoods; quercitron and fustic of the yellow dyewoods, and of the animal dyestuffs, the cochineal bug. Indigo-bearing plants had also been discovered, and the Central and South American indigoes became well known articles of commerce.

At the same time the East Indies and Africa furnished camwood, sanderswood, sapanwood and turmeric. All these, in addition to the already known madder, alkanet, young fustic, weld Persian berry and indigo, gave the dyer a very full assortment of dyeing materials. With the exception of indigo, all these dyestuffs required the use of metallic salts to develop the color or bind the color to the fibres. These assistants came to be known as mordants.

This may therefore be called the Age of Mordant Dyestuffs, and the dyeing operations were of a complex nature. This led to many so-called secret processes, the materials used and methods of handling being guarded most carefully from business rivals. In some cases they became a family heritage, being handed down from father to son, great care being taken that the knowledge should remain solely personal information, and this in many cases resulted in ultra-conservatism, and stifled efforts that would have been exerted in the line of practical improvement. Novelties were naturally looked on with suspicion, and new methods, if generally known, were not encouraged.

The colors resulting from the fact that these natural dyestuffs were mordant colors and required more or less careful treatment in their production, were generally considered "fast," in the sense of the term as now regarded.

The development of the indigo trade during this period is also notable. At first coming from the East or India, the Europeans had made use of its coloring principle in preference to woad grown in their own countries, and then, when it was found in America, it may be said to have been generally distributed throughout the world. The basic principle of its application has always been the same, that is, its transformation into soluble indigo white and then re-oxidation into the insoluble blue color. The means of bringing about the formation of indigo white during this period are very curious. All sorts of mixtures were used, some causing fermentation and others, in later years, producing reduction.

Toward the close of this development of the art of dyeing, the consumption of these natural coloring matters increased to such an extent that great efforts were made to extract and concentrate the coloring matters into a

more convenient form. This was done so effectively that the original forms of the dyewoods were replaced by extracts of varying degrees of concentration with all the properties preserved and the disadvantageous impurities of the original dyeing material removed. This form may be said to represent the highest development of the natural dyestuffs.

III. **The Era of Synthetic Dyestuffs.**—Before, however, the natural dyestuff industry had reached its culmination, certain influences were at work, which in a comparatively short time were destined to practically cause its extinction, for with the advance and development of the science of chemistry during the nineteenth century, came the investigations into the nature of the dyestuffs and coloring matters in common use, and in 1856, the discovery of Sir William Perkin, that a very brilliant coloring matter could be made by chemical methods from coal-tar, marked the beginning of the synthetic dyestuff industry. This color known as mauve, the subject of the first coal-tar color patent, was the first of an ever-increasing number of dyestuffs, which at that time were particularly attractive to the public, on account of their previously unattainable brilliancy of shade and to the practical dyer, on account of their ease of application on the fibre.

The discovery of mauve, Hoffman's violet, and similar colors, resulted in a broadening of the investigations, and in 1858, Griess discovered the diazo reaction, as it is termed, which is the basis of the largest group of synthetic dyestuffs. The first of these introduced commercially was amido-azo-benzene, manufactured by Sampson, Maule and Nicholson, in 1863, and in the same year in England, Lightfoot discovered the method of dyeing vegetable fibres with what is known as "aniline black." While his method of application has been altered and improved, this black has come to be considered the standard for cotton blacks and all other blacks are still considered inferior.

While the coal-tar color industry was yet in its infancy, in 1868, Graebe and Liebermann made a discovery that was in its results a very serious attack on the use of natural dyestuffs. This was the synthesis of alizarine from anthracene in coal-tar. Alizarine was at that time obtained from madder root, and was the most important of the natural red dyestuffs. The result of this discovery in a short time was the production of alizarine on a commercial scale from anthracene, and this soon reduced the trade in madder and its preparations to practically nothing; thus changing the commerce of many countries by contracting the demand for an important natural product, "Madder-red" continued to be known for some time, but the actual product used was derived from coal-tar.

In the experiments with anilines and anthracenes and other derivatives from coal-tar, it was found that by a process of building up, other coloring matters could be obtained, some similar in nature, others differing widely from the original material. With this encouragement always present, the list of new dyestuffs grew steadily from year to year. The fluorescein colors

were introduced in 1874, three years after the discovery of the parent body. In 1877-8 the sulphonated azo colors were placed on the market, opening the large field of acid dyeing wool colors. Many additions were continuously made to each of the known groups of colors, but in 1884 a new and very important addition appeared.

Up to that time nearly all the colors required a mordant in dyeing vegetable fibres not containing natural tannin. Either the fibre had to be prepared with tannin, or alum, or some other metallic salt had to be used in the dyebath, but in that year Boettiger produced Congo red, which dyed unmordanted cotton in a bath containing common salt only. Other dyestuffs belonging to this group appeared rapidly, and at the present time the "Tetrazo Dyestuffs," "One-Dip Colors," or whatever else they may be called, outnumbered those of any other class.

Closely allied to these are the colors which are developed on the fibre. The first of these, primuline, apeared in 1887. Their advantage consists in their comparative fastness to the processes of manufacturing. Under this head may also be classed the insoluble azo colors, which are also formed directly on the fibres. These were first put on the market in a workable form in 1889, although the method had been suggested before. These colors, with many additions and improvements, have been found to be of great utility in the lake and pigment trade.

In 1873, a mysterious dyestuff, commercially known as "Cachou de Laval," appeared. It was made by heating various organic substances with sodium sulphide. This, while used for dyeing in a small way, was little thought of until 1890, when the first sulphur blacks, made from coal-tar derivatives, as raw materials, appeared. The production of these bodies led to serious investigation of the possibilities of sulphide combinations and the practical results can be seen in the large consumption of sulphur or sulphide colors at the present time.

The colors during the first period of production of aniline dyestuffs were noted especially for their brilliancy of shade and ease of application, but after the novelty had worn off it became necessary for them to meet competition in the shape of the older natural coloring matters. Most of them, when combined with suitable mordants, gave shades which, while not as brilliant as the "aniline" colors, were much more permanent. This led to the development of colors that would compare favorably with, or excel the natural dyestuffs in regard to fastness. It was noted from the first that the anthracene derivatives, as a rule, were faster than those from aniline, and therefore, with the increasing demand for fastness, greater attention was paid to the anthracene compounds, and this resulted in a full line of dyestuffs, available either for mordant, acid, or vat dyeing, all remarkable for their resistance to injurious influences.

Many of these are products of the last ten years. With the development of the fast colors among the synthetic dyestuffs, the decline in the

consumption of natural dyestuffs, even for special purposes, began, and with each step in advance of the one, the other receded. One-dip cotton colors of sufficient fastness and with simple methods of dyeing, soon replaced logwood blacks and slates, and the introduction of chrome developed blacks for wool, with much greater fastness to light, left little room for its use on that material. Slowly, at first, but later more rapidly, the most important of the natural dyestuffs lost ground, so that at the present time, "as fast as logwood black" has no commercial meaning.

During all the changes involving the other colors, one natural dyestuff held its place without question, and while many substitutes were proposed, none were of any material use. But the synthetic dyestuff manufacturer solved the problem at last, in the same manner as in the case of madder. As early as 1880, a process had been invented by Dr. A. Baeyer, for the synthesis of indigotine from Toluene, but for years this was found to be commercially unprofitable, until a new process was introduced by Heumann in 1890, using benzine and naphthalene, as raw materials. Before this method was technically successful, the Farbwerke of Hoechst, perfected a method for the use of the original ortho-nitro-benzaldehyde process, and started the manufacture of synthetic indigotine, commercially, in 1896, while the Badische Aniline and Soda Fabrik, at the same time used Heumann's process. It was soon after discovered that the addition of sodium amide increased the yield of indigotine in the Heumann process, making it satisfactorily economical, and at last the synthetic dyestuff makers were able to dislodge natural indigo with indigo made synthetically from coal-tar.

As soon as the manufacturer was in a position to compete commercially with the natural product, the market for the natural product fell off and is growing smaller from year to year. At this time it can be said that there is no market for the natural product, except where manufacturers are ultra-conservative and in countries where it is indigenous. The total consumption annually in the United States is about 1,500,000 pounds of 100 per cent indigotine. This may be said to be the commercial end of the natural dyestuff as applied to textile fibres, and their use practically goes out with the nineteenth century. The twentieth century, so far as we can now foresee, will be one of synthetic dyestuffs.

The synthetic dyestuff industry originated in England, as the names of the early colors indicate, but as technical education advanced more rapidly in France and Germany, it was transferred successively to those countries. At the present time, most of the manufacturing is in German hands, as most of the works in other countries are subsidiaries of the German works. As all these employ large corps of research chemists, the industry is steadily developing and advancing, and the era of synthetic dyestuffs, in which we now live, is bound to produce coloring matters, the application of which will be of benefit to consumers as offering advantages in cost, or in fastness.

HISTORY OF THE DEVELOPMENT OF THE COAL-TAR DYE INDUSTRY IN THE UNITED STATES.

BY J. F. SCHOELLKOPF

To properly understand the causes of the slow development of this industry in the United States, it will be advisable to give a short sketch of its inception and progress in Europe up to the present time.

Though Perkin began the manufacture of coal-tar dyes in England, in 1857, they were first produced on a considerable commercial scale in France, and at a later date, their manufacture was taken up in Switzerland and Germany. But while the growth of this new industry was not extraordinary in the first named countries, the history of it in Germany reads like a fairy tale. One can truthfully say that Germany's greatness and present supremacy in the chemical arts, dates from the time it actively engaged in the production of coal-tar dyes. From practically nothing in 1862, the value of the output of the German factories had risen to $6,000,000, in 1874; to $12,500,000 in 1882; to $17,000,000 in 1890; and to over $50,000,000 in 1907. This in the face of the fact that the products were not only vastly improved in quality, but also very materially cheapened in price (magenta from three dollars per pound to sixty cents; aniline blue from eight dollars per pound to seventy cents).

Germany has a capital of at least $100,000,000 invested in the industry which gives employment to fully thirty thousand hands directly, and to at least as many more indirectly. The amount of chemicals and other materials consumed by this industry is simply stupendous, one factory alone using 300,000 tons of coal annually, and producing for its own consumption 150,000 tons of sulphuric acid, besides enormous quantities of other mineral acids and heavy chemicals. The main reason for this wonderful growth in Germany, was probably the judicious co-operation of theory and practice, the working together of factory and university, which in no other country was carried out to the extent it was in Germany. During this period of rapid development, it is obvious there could be no surplus of scientific or expert manual help to start factories of a similar nature in America. All the chemists that graduated from German universities, and who had chosen this branch of chemistry as their specialty, immediately found remunerative employment in one of the home factories. No one thought of leaving the "Fatherland" and seeking his fortune elsewhere.

These conditions, however, changed radically about the year 1880. The

universities and chemical schools had continued to turn out coal-tar chemists in increasing numbers and the home factories were finally no longer able to take care of all of them, and naturally they looked around for other fields of operation.

At this time the United States apparently presented an inviting field. The consumption of colors was already large and constantly increasing. The import duty at that time was thirty-five per cent ad valorem, and fifty cents per pound specific, which, taking into consideration the low prices the dyes had reached, was ample protection. There were, as yet, no colors produced in this country, if one excepts the magenta turned out by the now extinct Albany Aniline Color Works. They produced a small quantity of poor magenta in a very crude way and had been doing this for ten years without attempting to enlarge by adding new colors to their product. As stated above, America presented an inviting field and during the years 1880 and 1883, no fewer than nine different plants for the manufacture of coal-tar dyes were established. The prospect of becoming independent of other nations for our supply of these important colors was bright indeed, until the passage of the Tariff Act of July 1, 1883. This act abolished the specific duty of fifty cents per pound; leaving ad valorem duty of thirty-five per cent on coal-tar colors or dyes, and twenty per cent on coal-tar preparations not colors or dyes. This left a net protection for the colors of nominally fifteen per cent, but it will appear later that even this meagre protection was completely neutralized through various circumstances.

The evil effects of this adverse tariff legislation showed itself almost immediately. No new factories were started, and within one year after the new tariff took effect, five of those already established were forced to succumb and go out of business. The remaining four would have gladly followed their example but they had invested large sums of money in plants (the Buffalo factory had expended about $500,000 in this way), which would not have brought ten cents on the dollar if sold. So they decided to continue to operate their factories, hoping for more favorable legislation in the future. But thus far they have always been bitterly disappointed. At every tariff revision this industry, which if properly fostered would be of such enormous importance to the chemical industry at large, has been treated in a most unfair and unkind manner. The parties interested have repeatedly asked for an increase of duty, which has as often been refused. They have asked for a decrease of duty on raw material, which was only partially acceded to in the Dingley Bill. As their raw materials are not made in this country, and never will be under existing conditions, it is not comprehensible why this latter request has not been granted. They finally petitioned Congress to change the phraseology of the paragraphs referring to coal-tar colors and alizarine red, to prevent fraud and misunderstandings at the Custom House. But even this just request, which was recommended

by the Appraisers' Department in New York, was only acceded to finally, when the Dingley Bill went into effect.

It is true the Wilson Bill had placed coal-tar products, constituting part of the raw material for the colors, on the free-list, but the duty on the colors at the same time was placed so low that it fell short of covering the difference in cost of production between here and Germany. It is obvious that under such conditions there was no incentive on the part of the American manufacturers to increase their plants, and they continued to pursue a waiting policy.

While the Dingley Bill was up for discussion, the American manufacturers of coal-tar dyes asked for free raw materials and a duty of thirty-five per cent on the colors. The bill, as finally passed, placed the duty on colors at thirty per cent, but, on the other hand, most of the coal-tar products used in the manufacture of the dyes were again placed on the dutiable list.

The Dingley Tariff Bill improved matters to some extent, inasmuch as the American manufacturers were now able to at least manufacture without loss, those colors for which the raw material could be imported free of duty, but for those colors that necessitated dutiable raw material, conditions were worse than they had ever been before, in fact to even attempt to make this class of colors, was altogether out of the question. The domestic production has increased considerably during the last decade, but the increase would have been far greater if this industry had received fair treatment at the hands of Congress.

It would seem that if the American chemical manufacturers in particular, and the American people generally, realized the importance of the aniline color industry, they would positively demand proper protection for this industry. One can truthfully say that the chemical industry of no country, can become really great unless the aniline color industry is properly fostered. This statement is amply proven by the fact that Germany, with a highly developed coal-tar color industry, leads in all chemical branches, while England and France, who formerly predominated in this field, have fallen far behind Germany, and only because they did not keep step with the latter country in the development of the coal-tar color industry.

FLAX: ITS CULTIVATION AND MANUFACTURE.

The cultivation of the flax plant (Linum usitatissimum), for textile purposes, dates from the remotest antiquity. The Egyptians over four thousand years ago excelled in the art of manufacturing fine white linen, some of which was comparable to our silken materials for smoothness and softness, and so fine as to be transparent, as is evidenced by the burial bandages of King Pepy and King Merèré (2530 B. C.) and by a transparent overdress of one of the kings of the Sixth Dynasty (1530 B. C.) now in the Berlin Museum; in the same place are to be found combs for combing the flax. The German writer Seitzen mentions the fact that he had found several napkins within the folds of the covering on a mummy and that he had them washed several times without injury and used with great veneration "this venerable linen, which had been woven more than 1,700 years."

The Egyptians boiled their flax instead of "retting" it and afterwards hammered it to separate it from the outside; this is depicted on the monuments of that ancient people; as well as the weaver plying his shuttle to the warp of flax, and the peasants cultivating the flax in the fields much as it is done to-day.

From the Egyptians, the cultivation of flax passed to Palestine; there is scarcely a book in the Old Testament in which flax and linen are not mentioned. The Greek maidens in the time of Homer, spun the flax and wove the linen as those of Egypt had done before them. From Greece the manufacture of linen is traced to Rome, and the Romans doubtless carried it to the barbaric northern nations, whom they conquered, and in a measure civilized.

The common flax or lint, is an annual; a native of Egypt, of some parts of Asia, and of the south of Europe, not truly indigenous in Britain, but now naturalized as it is in many other countries. The universal use of the plant in all parts of the world is doubtless due to its physical stamina, which is of the most enduring and diversified nature; it grows to great perfection amidst the snows and rigors of northern latitudes, and maintains a healthy condition in sunnier and warmer climes. (See Plate 11.)

In the United States it is grown largely, but merely for the seed and oil, the process of its preparation for textile use, which must be done mainly by hand, being too expensive and tedious for the American farmer.

The best flax for the purpose of manufacturing into linen is grown in Belgium, where it is extensively cultivated, particularly in Southern Brabant, Hainault, and West and East Flanders, where the most beautiful

flax is spun for conversion into Brussels and Mechlin lace; that flax grown and prepared at Courtrai being particularly desirable. The flax of these countries sells at from $350 to $2,000 a ton, while that used for the laces mentioned above, has been known to be sold, when hackled, at $20 a pound, or nearly $45,000 a ton. At least half of the flax for manufacturing purposes is grown in Russia. In India, flax is grown mainly for the seed. The flax of New Zealand is a valuable fibre, quite distinct from the common flax and is obtained from the leaves of an endogenous, instead of the stem of an exogenous plant. Linum usitatissimum is an annual plant and grows with a slender upright stem, branched near the top; the seed is sown in April, the plant blossoms in June or July, and the seed commonly ripens in September. The fibre of which flax is composed, when examined under a microscope, appears to consist of smooth transparent tubes intersected at short intervals by joints or knots similar to the bamboo or other reeds. This fibre, spun into yarn, is manufactured into linen cloth.

According to the analysis of Liebig, flax is composed of:

Carbon	38.72
Hydrogen	7.33
Nitrogen	0.56
Oxygen	48.39
Ashes	5.04

The flax being sufficiently ripened, is pulled only in dry weather, the stalks being kept even, like a brush, at the root end, and the short stems kept separate from the long ones; on the following day it is "rippled," to take off the seeds. The "rippling" machine consists of an instrument like a comb with iron teeth, round, smooth and tapering, about twelve inches long, fastened into a wooden frame and placed so close that the pods cannot pass through. This frame is placed at the end of a plank or long stool on which the operator sits.

The next process is to obtain the fibre free from the woody core or boon of the stem; this operation is called retting, and has to be very carefully performed. The bundles of flax are steeped in water till the boon begins to rot, when it can be readily separated from the fibre. When it has been sufficiently steeped, the flax is spread out on the grass to complete the decomposition of the boon. In some districts, the practice is to place the flax on the grass and allow the dew and rain to "ret" it, which requires a much longer time and is not feasible where land is valuable. Attempts have been made to remove the fibre by machinery without retting it, but the fibre so obtained is inferior in quality. There are several methods which are successfully applied to facilitate the process of retting, by which a much greater amount of the fibres is extracted from each ton of straw, with a great gain also in the time of preparation. In 1847, Mr. R. B. Schenck, of New York,

introduced into Ireland a method which, though it was by no means new, having been proposed by Professor Schudweiler in Belgium, and tried in Holland several years before, and also employed by the Malays and the natives of Bengal, was of great service in leading to further experimentation and vastly superior results. (See Plate 11.)

Schenck's method, which is now little used, was to place the flax in vats in which it was kept down by means of a strong framework; water is then run into the vats and is absorbed by the flax; steam is now admitted till the temperature of the water is raised to and maintained at about ninety degrees Fah. Fermentation sets in in a few hours and is maintained for about sixty hours, when the decomposition of the gummy or resinous matter in the stalk is completed. The mucilaginous water is then withdrawn from the vat, the flax taken out, separated and dried, either in the open air or in desiccating rooms, according to circumstances.

Watt's method, which with the improvements of Pownall, is the preferred system, consists of a chamber with a perforated bottom, in which the flax is laid; the top of the chamber is double and is filled with water to act as a condenser. Steam is admitted to the case, which frees the flax from certain volatile oils. The steam rising to the top of the chamber is condensed by contact with it, and falls in showers on the flax beneath. In thirty-six hours the flax is taken out, and passed between rollers in the direction of its length, which presses out the water and decomposed gum, and splits and flattens the straw. Mr. Bower, of Leeds, England, rolled the stalks after steeping in cold or warm water, then steeped them and rolled them again. The most rapid process is to steep the flax for a short time and then exhaust the air from its fibres by means of an air pump. If this process is twice repeated, the gelatinous matter is removed in a few hours. The introduction of chemicals, to hasten the fermentation, is objectionable because of its weakening the fibres.

The flax prepared by Schenck's method made a coarser yarn than that from Watt's, and 100 tons of straw by Schenck's process yielded 5.90 tons of fibre; 100 tons of straw by Watt's process yielded 12.20. By Pownall's invention, the flax, after steeping, is passed between heavy rollers, after it is taken from the vats, clean water being kept flowing over the stems during the operation, to remove the gummy matters.

The flax, when retted and dried, is next passed through a machine having numerous fluted rollers, some of which have a reciprocating motion; this thoroughly breaks the brittle wood parts of the stems, and prepares it for the operation of scutching, which is now mainly done by scutching machines. Brushing machines are sometimes used to finally clean the flax before baling it for the market.

From the earliest period of recorded history up to the eighteenth century, the manufacturing of linen was one of the most extensive domestic industries of European countries; it was most largely developed in Russia,

PLATE XI—Flax

1. Field.
2. Field, Young Flax.
3. Flax in Blossom.
4. Sheaf of Flax.
5. Retting.
6. Hackling.
7. Hand Spinning.
8. Spinning Machine.

JAMES H LAMB Co.

Austria, Germany, Holland and Belgium, the northern provinces of France and certain parts of England, in the northern parts of Ireland, and throughout Scotland, the importance of the industry is shown by the special laws made in those countries to protect and foster it. Some notable specimens of figured-stuffs such as damasks, made of linen, or of silk and linen, in Spain and Italy as early as the fourteenth century, are seen in several industrial art museums in England and in Europe. The ground of the celebrated Bayeux tapestry, which was made in the eleventh century, is of linen. Flanders was celebrated as early as the eleventh century for the weaving of table linen, and many Flemish weavers from that time on, settled in England, where the linen manufacture was fostered by bounties.

The first mill for spinning linen yarn by machinery was built in Darlington, England, in 1787, the machines being the inventions of John Kendrew and Thomas Porthouse, who, in 1787, obtained a patent for a mill or machine on new principles for spinning yarn from hemp, flax or wool. In Scotland, the first flax spinning mill was erected in 1790, near Glarnis, and several were shortly afterwards established in Fife. By degrees, these machines, crudely imperfect as they were, were developed by innumerable improvements and modifications into the perfect system of machinery with which the spinning mills of to-day are fitted, though the mechanical devices for the spinning of linen were slower of development than those for cotton; indeed, the speedy development of the cotton industry had a disastrous effect upon the manufacture of linen. In 1810, Napoleon, to foster the industries of France, offered a million francs to the next person who should invent the best machine for spinning flax and almost immediately Philippe de Girard patented in France, important inventions for the spinning of flax, wet or dry. He failed, however, to receive the promised reward, nor was his genius recognized by his countrymen, but be met with more recognition abroad, for in 1815, he was invited by the Austrian government to establish a spinning mill at Hirtenberg, near Vienna, which was run with his machinery for several years, but was not a commercial success.

Flax goes to the mills in bales, where it undergoes the operations of hackling, preparing and spinning, before it is woven into cloth.

Hackling, or heckling, the first preparatory process, not only combs out and disentangles and lays smooth and parallel the separate fibres, but it also splits up and disintegrates the strands of fibre which up to this point are agglutinated together. This, until recent times, was performed by hand, and was a very important operation, requiring much skill and dexterity; a certain amount of hand heckling is still done in Ireland and on the Continent.

The general principles of the several machines for hackling are the same, though there is some variation in their construction. The machine consists of endless leathern sheets moving over rollers placed at some distance apart with proper driving-gear. A number of heckle stocks placed at regular intervals are fixed on the surface of these sheets or bands, two

of which are placed opposite to, and so near each other that their respective heckle pins intersect where the actual heckling takes place. At this part of their course, the sheets move in a nearly vertical direction downward, and heckle the flax, which is fixed in a holder and hangs down between the sheets. (See Plate 11.)

Preparing.—The operations in this stage are varied, the object being the assortment of the dressed line into qualities suitable for spinning the different counts of yarn, and the drawing out of the fibres to a perfectly uniform sliver containing an equal quantity of fibre in any given length. The "stricks" are first sorted and are then passed to the spreading and drawing frames, a series of machines all similar in construction. 1. The spreading frame, where the flax is formed into a continuous ribbon or sliver; 2, The drawing frames, on which this sliver is doubled and drawn out by rollers through travelling gills with steel teeth. There are usually three drawing frames, though sometimes four are used, each machine having finer teeth than the one before it. The object of this careful process is to produce a sliver of uniform size throughout, in which all the fibres are parallel. Then follows the roving frame, through which the sliver is passed singly. Though similar to the drawing frame, this machine has in addition a flyer and bobbin; the former slightly twists the sliver and winds it upon the bobbin.

The rovings are now spun; the fine yarns being spun wet with water at a temperature of 125 degrees F., dry spinning being used for the coarser yarns. (See Plate 11.)

In weaving, the hand loom is still used in fine linens, though the power loom is now universally used for the weaving of ordinary linen goods. There are many obstacles to be met in the application of the power loom to the weaving of linen—the principal difficulty being the hardness and lack of elasticity of the linen wefts, and this and the pertinacious competition of the hand weavers delayed the adoption of power machinery for linen weaving for some years. The various operations of weaving linen on power looms do not differ from those employed in weaving cotton, nor is there any significant modification of the machines employed. The yarn is treated with flour paste and dried before being wound on the beam.

Bleaching.—There are in linen, intermingled with the fibres, which constitute the thread, minute particles of the woody parts of the flax which add greatly to the difficulty of bleaching the fabric; were it not for these fragments there would be no more difficulty in bleaching linen than there is in bleaching cotton.

The process of bleaching linen consists in steeping it in cold water for several hours, for the purpose of removing the flour size used in the weaving, after which it is boiled in a large iron vessel heated by steam in a weak solution of corbonate of soda, lime water and gum fustic. It is boiled under slight pressure for twelve hours in this fluid; then it is

thoroughly washed and spread out on the grass from five to eight days. After two or three such treatments, the linen is immersed in a strong lather of soap and subjected to the action of two fluted pieces of wood, moving in alternate horizontal directions. Then after another boiling and exposure on the grass, it is dipped for twelve hours in a weak solution of vitriol.

The number of the operations varies much according to the kind of linen to be bleached, the process being extremely long and tedious. After being properly bleached, washed, and dried, the linen is "finished" by passing it through a solution of starch which is squeezed out between rollers; it is then put through a heavy calendering machine or beetling mill for the purpose of imparting a glossy finish and is then made up into pieces for sale.

Linen is manufactured in most European countries and in Russia; France, Belgium, and Great Britain being the principal manufacturing centres. France is celebrated for her cambrics and beautiful damasks. In the United Kingdom, the finest fabrics are made in Belfast and other places in Ulster, and consist of lawn and cambric handkerchiefs, surplice linens, printed linen for gowns, damask table linens, shirtings, sheetings, and towellings of superior quality. At Dunfermline and other places in Fife, Scotland, diaper, towelling, damasks, and plain fabrics of medium weight are largely produced. Upholstery linen is made at Kirkcaldy; similar goods are manufactured at Barnsley, in Yorkshire, but Leeds is the chief seat of the manufacture in England. Heavy fabrics, such as sailcloth, canvas and sacking, are the mostly made in Forfarshire.

The linen industry has never attained a firm standing in the United States. Efforts were made to promote the growth of flax in colonial times and to introduce the spinning and weaving of linen goods, but the invention of the cotton gin by Eli Whitney placed in the hands of the American people a fibre that was cheaper, easier to manipulate, requiring less care in its preparation, and easier by far to spin and weave than is flax. Then America is the home of cotton, and there is no American production of the flax fibre suitable for spinning, nor do the long and tedious processes necessary to convert it into a salable commodity commend themselves to the American farmer. The linen industry at the present time is not extensive in the United States, still the increase in the past twenty years has been great, and there are certain fields of the linen industry which American manufacturers occupy to a great advantage; for these branches, they import the flax in bale. There is a large demand for linen carpet-yarns; the shoe manufacturing industry of the United States calls for an immense amount of linen thread, and in the production of these two articles the American manufacturers are unrivalled. The market for towels and towelling is practically unlimited, and American manufacturers are engaging largely in the production of those goods. The readjustment of the tariff in 1897, rendered it possible for them

to compete with the foreign production by reducing the duty on such yarns as are required in these special lines of goods to a revenue basis, and increasing the duty on the manufactured articles. Several large cotton manufacturing establishments are engaged in this industry and consume 1,500,000 pounds of linen yarn annually.

Besides the above there were in 1905, fifteen establishments engaged in the manufacture of linen goods with a combined capital of $6,293,878; employing on an average, 3,811 persons; value of products, $5,856,388.

HEMP, JUTE AND KINDRED FIBRES

While the term hemp should properly be applied only to the bast fibre of the plant Cannabis sativa, it is applied indiscriminately to the fibres of widely differing plants; so generally is this done, that it would often be misleading to use the word without a prefix, such as Russian hemp, sisal hemp, sunn hemp and scores of others that relate to entirely distinct kinds of fibres. Cannabis sativa is an annual herb, having angular rough stems and alternate-lobed leaves; it belongs to the same natural order as the hop, and, like it, has both male and female plants, a circumstance which necessitates two gatherings of the same crop—the male ripening and dying earlier in the season than the female. The height of the plant varies according to the season, and, though it sometimes grows about fifteen feet, it commonly is about eight to ten feet high. There is but one species of true hemp known, the C. indica and C. Chiensis, owing their differences to climate and losing many of their peculiarities when grown in temperate regions.

Hemp supposedly originated in some part of temperate Asia, spread westward through Europe and southward through the Indian peninsula. It grows wild to this day on the banks of the Ural and the Volga, extends to Persia, the Altai range and Northern and Western China. It is also found in Kashmir and on the Himalayas, growing vigorously at an altitude of 6,000 or even 10,000 feet.

Hemp has been employed for its fibre from remote antiquity. It is mentioned by Herodotus as growing both wild and cultivated in Scythia, and he describes the hempen garments of the Thracians as equal to linen in fineness; Hesychius tells us that the Thracian women wove sheets of hemp; and Moschion, who wrote about 200 B. C., records the use of hempen ropes for rigging the ship "Syracusia," built for Hiero II. It is of equal antiquity in India, having been cultivated there for its fibre as well as for use as a drug, while the medicinal and intoxicating properties of the plant have probably been known in Oriental countries from the very earliest times. An ancient Chinese herbal, part of which is dated 500 B. C., while the rest is of a still earlier date, notices the seed and flower-bearing kinds of hemp. Hemp is continually referred to as a remedy by early writers, and its use for medicinal and dietetic purposes spread throughout India, Persia and Arabia in the Middle Ages. In some countries, notably Persia, Northern India, Arabia, many parts of Africa and Brazil, the plant is still mainly grown for its gum. In addition to the fibre and resin, it yields an oily seed

used as a food for singing birds, and in very slight proportion as feed for cattle.

Hemp is grown for its fibre in the United States, Italy, Germany, Russia, Holland, Hungary, Turkey, England and Ireland, and to some extent in India, and it thrives well in Algeria, the finest being grown in Italy, though the Italian is almost equalled by the Russian fibre. Hemp is subjected to much the same methods of preparation as flax, being broken, retted, scutched and combed or hackled. (See Plate 12.)

Hemp seed was ordered for Plymouth Colony as early as 1629. It is chiefly grown in the States of Kentucky, Missouri, Tennessee, Ohio, Indiana and New York. The production of hemp in the United States reached its highest point in the year 1859, the amount raised being 148,986,000 pounds; since then it has declined 137.235,370 pounds, the decline during the last decade being 11,271,370 pounds, or forty-nine per cent. Several reasons exist for this declension, among which are the introduction of Manila hemp, the large importation of jute, the decline in prices of hard cordage fibres, such as sisal, and the use of cotton for twine and yarns.

Abaca, or Manila hemp, is a structural fibre obtained from the leaf sheath of the plant, Musa textilis, a species of the banana family. The Musa is quite a large and specialized genus, some of the species comprising several varieties. The Filipinos divide it into three groups: the plants which produce the edible banana of commerce (Visaya sagiry); abaca, which produces the fibre we are now describing; and the wild banana (pacol), which has no defined economic value, though it, in common with all the rest of the species, produces a fibre of more or less strength. Abaca is indigenous only to the Philippine Islands, and there only has it been successfully cultivated, though it has been introduced into India, Borneo, the West Indies, Florida and other parts of the world, the plant itself growing fairly well, but the fibre being of an inferior quality. In 1873 it was introduced into the Andaman Islands with a little better success, the best fibre there produced being about equal to the medium from the Philippines. Though grown throughout the Philippine Archipelago, it thrives best in those provinces where there is an abundant rainfall and a high relative humidity of the atmosphere, requiring a uniformly moist and warm climate. The first authentic account of abaca in the Philippines is given by William Dampier, an Englishman who voyaged among the Philippines in 1686 and wrote a full and interesting account of those islands. He mentions "the fibre of the banana tree" and the women as wearing scarfs or sashes made from it. The fibre was first exported from the islands about the beginning of the eighteenth century, but the exports were unimportant until about 1850. In 1820 John White, a lieutenant in the American Navy, brought a sample of abaca to Salem, Mass., and from 1824 to 1827 the fibre began to be used quite extensively in Salem and Boston.

The abaca plant grows to a height of fifteen to twenty-five feet, the

leaves are oblong, and it bears a non-edible fruit, containing seed. Primitive methods are still in use on the abaca plantations. The trunk of the abaca is twelve or fifteen feet long and about a foot and a half in diameter, around which are a large number of thick, overlapping layers, each layer being the stem or petiole of a leaf. The fibre is obtained from the outer portions of these leaf stems. These fibrous strips being removed, are next drawn between the edge of a knife or balo and a hard, smooth block. The apparatus consists of two uprights set in the ground, to which a horizontal pole is affixed with rattan canes. A short, strong knife, with a wooden handle, is firmly attached on a pivot or fulcrum to the upper surface of the horizontal pole, the handle being attached by a rattan cane to a bamboo spring in the roof of the shed or the limb of a tree, under which the operation is performed. Another rattan cane is attached to a treadle which is worked by the foot of the operator. The spring in the roof above holds the knife upon the pole, while the fibre is being drawn beneath it. Pressure on the treadle releases this and allows a new strip to be inserted. This method is extravagantly wasteful, and, though several attempts have been made to perfect machines for doing the work of extraction economically, none have as yet proved wholly successful. The introduction of suitable machinery will do much to increase the abaca industry. (See Plate 12.)

After being stripped, the fibre is hung to dry upon bamboo poles for the space of two or three days, and, when dry, is tied in bundles and conveyed to the nearest market, the exporter sorting it and making it up into bales of 275 pounds each. The fibre for the home manufacture of cloth is more elaborately treated. Of a glossy white color, light and strong, of clean, even texture and eight to twelve feet long, abaca fibre is infinitely superior to any other fibre in the making of cordage, particularly for ships' ropes, its lightness being a marked feature of its value. Tested against a rope of English hemp, both cords being three and one-quarter inches in circumference and two fathoms long, the English rope broke under a strain of 3,885 pounds, the Manila rope stood a strain of 4,669 pounds before giving way. In a second test of a rope one and three-quarter inches in circumference, the Manila rope broke with 1,490 pounds, the English, with 1,184.

A very large percentage of the production of abaca fibre is used in the manufacture of cordage, twine, ropes and cables. Immense amounts are used in the United States in the production of binder twine, Manila paper being manufactured from old disintegrated ropes. In the Philippines, although a large quantity is used for cordage, its most important use is for the weaving of cloth for wearing apparel, for which purpose looms are to be found in nearly every town in the islands, the fibres being frequently combined with either cotton or silk, the fabrics being of every degree of fineness. In Europe also, especially in France, many articles of clothing are made from abaca, such as shirts, vests, veils, crapes, neckerchiefs, robes and

women's hats, these goods being highly esteemed both for beauty and durability. The fibre is also used for upholstery, packing, brush-making and fish-nets.

Sunn is the fibre of the Crotelaria juncea, a leguminous plant, a native of India. It strongly resembles Spanish broom, but is an annual. Sunn has long been cultivated in India for its fibre, which is cleared by retting. While the fibre is not so strong as that of hemp, good cables, canvas and cloth are made of it. Much of it is imported into Great Britain. It is called Bengal hemp, brown hemp, etc.

Sisal hemp is the fibre of the henequin plant of Yucatan, Agave rigida elongata. This plant has been utilized for centuries, having supposedly been initiated by the Toltecs in Yucatan about A. D. 1060; but it is only within a comparatively few years that it has become of commercial importance. In 1783 a commission appointed by the Royal Spanish Navy investigated this fibre and reported favorably upon it. In 1839 an association was formed in Yucatan to promote the cultivation, but the crude and imperfect methods of extracting the fibre at that time prevented the success of the undertaking. The movement led, however, to the offer of a reward of $10,000, Mexican, by the state government to the inventor of a satisfactory machine, which resulted in the invention of the "raspador," from which have been evolved the improved automatic machines which have made the sisal industry what it is to-day.

From Yucatan, sisal hemp has been introduced into the Bahamas, where the industry has attained considerable importance and become firmly established. In 1893. 20,000 sisal plants were imported into Hawaii by the Commissioner of Agriculture and Forestry, and some years later the Hawaiian Fibre Co. was founded, and in 1903 it was calculated that there were fully 10,000 acres of sisal under cultivation in Hawaii. The plant has also been introduced into the Mauritius, the Caicos Islands, Cape Colony, Natal, West Africa, Australia and India. (See Plate 12.)

Sisal was introduced into Florida by Dr. Henry Perrine about 1836 and '37, and some was planted at Indian Key and some planted at Biscayne Bay, and from this the plant spread rapidly, though little was done until late years to promote its cultivation.

The true sisal plant, Agave rigida sisalana, is a native of Hawaii, and has been introduced into the Philippine Islands with very satisfactory results. This plant is very closely allied to the maguey of the Philippine Islands, which has recently been identified as Agave cantula. One acre will yield about 730 pounds of fibre, and its market value approximates that of sisal. (See Plate 12.)

In 1880 there were 165 establishments manufacturing cordage and twine in the United States, with a capital of $7,140,475; in 1890 there were 150 establishments, with a capital of $23,351,883; and in 1900 there were 105 establishments, with a capital amounting to $29,275,470; in 1905 there

PLATE XII—Hemp and Sisal

1. Cutting the Hemp.
2. Breaking the Same.
3. Hackling.
4. Stripping and Scraping.
5. Fibres of Hemp and Manila.
6. Sisal Field.
7. Cutting Leaves.
8. Trimming of Thorns.
9. Loading Leaves on Cars.

were 103 establishments, with a capital of $37,110,521; the decrease in the number of establishments being caused by the frequent consolidation of several small plants under one incorporation.

Sisal hemp and maguey are used in the United States principally for binder twine, tarred lath and fodder yarns, and for other cordage purposes. In Yucatan and South America sisal is employed in the manufacture of saddlecloths, hammocks, girdles, bridles, cordage nets and lines, while in the Philippines a great deal of maguey is produced for local consumption. The maguey plant was probably introduced into the Philippine Islands from Mexico. It is now cultivated in nearly every province of the archipelago. The fibre of the plant, which is white and finer and longer than the Hawaiian or Yucatan varieties, is obtained from the leaves; it is four to five feet in length, more wavy and fluffy than abaca, and also is extraordinarily elastic, which renders it of great value when used for cordage liable to be subjected to a sudden strain. In strength it is superior to sunn or to Russian hemp, coir, or jute, but inferior to abaca. The problem now encountering the planter is that of machinery for extracting the fibre in an expeditious and economical manner, retting now being the most common method of freeing the fibre, few of the planters up to now being in a position either to purchase the proper machines or to use them to advantage. Practically all of the Philippine maguey is shipped to Manila and baled on abaca presses

New Zealand hemp is a fibre obtained from the leaves of the Phormium tenax (of the order Liliaceæ). It is a native of New Zealand, the Chatham Islands and Norfolk Islands, and has been introduced into the Azores for economic purposes. The fibre has always been of importance among the Maoris as yielding material for clothing, mats, cordage, fishing-lines, etc. The leaves for fibre-yielding purposes come to maturity every six months, and the crop is therefore gathered twice a year. The material is harvested with immense care by the Maoris, only the properly matured fibres being selected. These are collected in water, scraped over the edge of a shell to free them from adhering tissues, and washed often in a running stream. This operation is necessarily very wasteful, and various methods have been resorted to for the accomplishment of the same purpose by mechanical means, or by retting with alkaline agents, but the quality of the fibre was greatly impaired, and no means have as yet been discovered whereby the fibre can be produced in the perfect condition in which it is hand-prepared by the Maoris. It is a cream-colored fibre, with a fine silky gloss, and is capable of being woven into the heavier textures for which flax is used, either alone or in combination with flax. It is principally used as a cordage fibre and as an adulterant of Manila hemp, being second only to the latter in tensile strength, though it is vastly more pervious to the effects of water. It is used also for the bands of self-binding reaping machines.

Jute or Jews' Mallow belongs to the genus Corchorus, eight species of which are recognized in India; two of these are extensively and widely

cultivated and supply the jute of commerce. Both have been introduced into the United States. The first of these, Corchorus capsulares, is an annual plant, growing four or five feet high. The "seedpods" are short and globular, rough and wrinkled." Corchorus olitorius is similar to the first, the chief difference lying in the fact that the seedpod is long and cylindrical, and of the thickness of a quill. The fine silky texture of its fibre and its adaptability for spinning purposes, and also the ease with which it is cultivated, have much to do with the popularity of jute. Many of the American plants, now classed as weeds, produce stronger and better fibre, but their cultivation is as yet experimental. The fibre of jute is employed in three forms of manufacture; it is woven into fine and coarse fabrics; it is made into fine twines and cordage, and it enters into the manufacture of paper in the forms of "jute butts." The chief seat of the jute-growing industry is in India, and its manufacture is a very important industry in that country. Jute occupies the fourth place in the export list of India. In 1862 India exported 10,000,000 pounds of fibre and rope, and 300,000,000 yards of gunny cloth, and in the same year Great Britain employed more than 30,000 spindles in spinning 80,000,000 pounds of Indian jute. One factory at Barnagpoor, near Calcutta, annually manufactures 30,000,000 pounds of jute. In 1872 the total exportation of Indian jute was 700,000,000 pounds, of which Great Britain received upwards of 395,000,000 pounds. In 1894-5 the exports of jute from India were nearly 649,000 tons.

More than half a century ago, some Scotchmen were impressed with an idea of the value of jute as a wearing material; they engaged in its experimental manufacture at Dundee, and after many repulses and difficulties were successful in discovering admirable processes of bleaching and dyeing the fibre. It is now successfully mixed with cotton, linen and silk, and is a material part of twilled stair-carpeting and of low-priced broadcloth. In combination with other textiles, it enters into the manufacture of a thousand articles of commerce, it imitates the gloss of linen, the lustre of silk, and the splendor of Axminster, Kidderminster, Brussels, and Venetian carpets. In 1872, there were in Dundee about one hundred jute mills, using more than 180,000,000 pounds of the raw material annually, and in 1883, the annual value of the flax, hemp, and jute manufactured in Dundee had reached the value of $15,000,000. To the jute industry, the city of Dundee owes its commercial prosperity and standing.

In the tenth U. S. census, only four establishments for the manufacture of jute are recorded; the number of these establishments in the twelfth census being eighteen, with a capital of $7,027,293; the annual value of their production being $5,383,797. In 1905, there were sixteen establishments with a capital of $11,019,132.

The flax, hemp and jute industries are so closely allied, owing to the fact that the three materials are often used in the establishments coming

under either of the single heads that it is necessary to group them for statistical purposes.

The infancy of the cordage industry in the United States was marked by no phenomenal growth, though rope-making was undoubtedly one of the earlier industries of the colonies. The work in the old rope walks was done by hand mainly; later, came horse or water power. After 1830, came the evolution of the modern factory, with rapid modern machinery, as in kindred industries. The era of the largest mills began in 1878, the manufacture being largely confined to the different Atlantic seaports, with the greatest percentage in Massachusetts. The decline of American shipping changed this, and numerous cordage factories sprang up all over the country, especially after the great demand for binder twine, caused by the invention of the self-binding harvester.

In 1843, the total amount of Manila hemp manufactured in the United States was only 27,820 bales, or 27,511,400 pounds. In 1863, the industry had increased to five times its size in 1843, and the War of the Rebellion brought a great demand for cordage, so that hemps accordingly advanced in price.

In 1860, the first importations of sisal hemp were made, but it rapidly became an important factor in the industry and its use rapidly extended in the following ratio:

Years.	Tons.
1860	200
1870	3,500
1880	13,000
1890	34,000
1895	50,000

In the cordage and twine factories, the amount of raw hemp and jute used in 1900 was as follows:

Hemp.	Amount.	Value.
Manila	123,241,820	$8,916,493
Sisal	146,352,853	8,827,131
New Zealand	6,344,371	352,528
Russian		
Rough	1,175,605	73,165
Tow	44,090	1,969
Line	349,558	25,063

Italian		
Rough	3,422,104	256,582
Tow	305,917	20,969
Line	296,920	27,752
American		
Rough	10,871,865	506,767
Tow	3,011,004	104,660
Line	1,258,266	63,965
Jute		
Butts	25,767,800	786,967
Yarns	74,281,100	1,107,899
Jute	339,051	21,070
Silk	4,774	24,414
Yarn	1,100	3,450
Worsted	682	308
All other materials		3,714,812

Ramie is a plant belonging to the Urticaceæ or nettle family, which from time immemorial has been cultivated in China. It is known to botanists as Boehmeria nivea, and is also known as "China grass" and "rhea." It has also long been cultivated in Japan, Borneo, Sumatra, Java, and the East Indies, and during the last century was introduced into other countries, reaching the United States in 1855.

The plant, when fully grown, is four to eight feet high. It is of rapid growth and produces from two to five crops a year without replanting. In China and Japan, where the fibre is naturally extracted by hand labor, it not only enters into the manufacture of cordage, fish lines, nets, etc., but is also woven into the most delicate and beautiful of fabrics. In England, France, and Germany, it has been put to the widest range of uses, being woven into a great variety of fabrics such as lace, lace curtains, cloth or white goods resembling fine linen, dress goods, napkins, table damask, table covers, bed spreads, drapery for curtains or lambrequins, plush, and even carpets. The fibre is susceptible to dyes of all shades and colors, and is sometimes finished with a lustre equal to silk. Its characteristics give it first rank in value as a textile substance; it is the least affected by damp of any of the fibres, and is one of the most durable, being three times as strong as Russian hemp, while its filaments can be separated almost to the fineness of silk. It can be used with silk, wool or cotton, and in certain forms of manufacture where elasticity is not essential can be used as a substitute for all of these textiles, as well as for flax. It is utilized in the manufacture of celluloid with much success and produces superior paper.

As yet, it has not been grown to any extent in any country except China and Japan, owing to the difficulty of decortication. It is asserted that the first attempt to decorticate ramie by machinery was made in India, in

1816, a flax and hemp machine being sent out from England for that purpose. Little was done during the next fifty years, but about 1860 the subject was resumed, and in France many machines have been invented, having the decortication of ramie as their object. The Favier machine, the Armand-Barbier, the Michotte, the Landtsheer machines are all undergoing experimentation, as are several American machines. Up to the present, the machines have been too costly and too slow in their results to encourage the cultivation of ramie upon a great scale.

ROPEMAKING AND ROPEMAKING MATERIALS

The story of the making of rope must needs be almost as old as the story of the human race. Prehistoric man must have had occasion to use cords or lines from the very earliest times, and ropemaking must have antedated the weaving of the first textile fabrics. Certain it is that the ancient civilized nations were proficient in the art. Upon Egyptian monuments are depicted various uses of that material, and specimens of Egyptian ropes of hemp covered with woven cotton, ropes of palm fibre, made nearly four thousand years ago, ropes of papyrus and ropes of plaited leathern thongs are in existence to-day. The Chaldeans, the Assyrians, the Israelites, must also have possessed a knowledge of ropemaking, without which no sailing vessels would be possible. China is known to have made rope at a very remote time.

Herodotus, to whom we are so greatly indebted for our knowledge of the manners and customs of ancient nations, makes numerous references to rope. He tells us that Xerxes, when invading Greece (480 B. C.), crossed the Hellespont on two bridges of boats, which were held together by immense cables stretched from shore to shore, a distance of nearly a mile. There were six of these ropes to each bridge, and they were twenty-eight inches in circumference, eight of them being made of flax and four of papyrus. The "Syracusia," that famous galley built for Hiero, King of Syracuse, by Archimedes (287-212 B. C.), was rigged with hempen rope from the island of Rhodes.

Savage tribes, too, all over the world, but more particularly those living in the vicinity of waters, have for untold thousands of years possessed the skill to make ropes and cords from an immense variety of materials, with more or less perfection of workmanship. As samples of these may be mentioned the native Peruvians, who used among other materials one called "totora." The tribes of the South Sea Islands are expert at making rope, for which they have abundance of native materials. The North American Indians manufactured ropes and cordage from such plants as cotton, yucca, agave, dogfanc, nettle; from the inner bark of trees, such as linden, willow and elm; from the fibrous roots of other trees, such as spruce and pine, and from the hair, skins and sinews of various animals. The Nootka Indians of Vancouver Island made rope for the purpose of harpooning whales from the sinews of the whale, bound together with small cord.

The name rope is applied to all varieties of cordage having a cir-

cumference of an inch or more. Twisted cordage of smaller dimensions is known as cords, twines and lines, all these varieties being composed of at least two, and in most cases of many separate yarns. From the smallest sizes and kinds to the largest, the whole art of manufacture is simply a twisting together by various means the fibres and yarns proper for the purpose. Modern rope-making requires the use of very strong machinery, owing to the comparative coarseness and heaviness of the materials used.

The twisting of the fibres together in a rope is essential, in order that by mutual friction they may be held together when a strain is inflicted upon the whole; the application of just the proper amount of twist is a matter of considerable importance. It must be sufficient to afford resistance without straining or impairing the strength of the fibre. "The degree of twist given to ropes is generally such that the rope is from three-fourths to two-thirds the length of the yarn composing it, and the lighter the twist, the greater in proportion is the strength of the rope. In a bundle of fibres, equal in length and strength, fastened at the ends, each fibre will, upon a strain being applied to the bundle, bear its proper share of the stress; and the strength of the bundle will evidently be measured by adding together the strength of the separate fibres. But if this bundle is twisted so as to form a thread, the strain will no longer be equally distributed among the fibres, for, by the torsion, the external fibres of the bundle will be wound round those that lie nearest to the centre, and in proportion to their distance from the heart of the bundle and the amount of the twist given, will form spirals more or less inclined from the axis of the thread. The external fibres will in consequence be longer than the internal ones, and the greatest share of the strain will be borne by the latter. The depreciation in strength from twisting of hard woody fibres is greater than is the case with fine, soft, flexible fibres, such as common hemp of good quality."

To obtain the best quality of rope it is necessary to select threads of the same thickness, strength, expansion and equal twist. The fibres of hemp being ordinarily only about three and one-half feet in length, and those of manila from nine to twelve feet, these fibres are necessarily overlapped among themselves and compressed together so as not to be drawn apart. This is effected by twisting, the fibres being continuously drawn out together from a bundle, in the right quantity to produce the required size of yarn; the yarns are then put together to form strands of the required thickness, three strands being twisted or "laid" together to form a "hawser-laid" rope, and three such hawsers forming a cable. Four strands laid around a central strand or core form a "shroud-laid" rope, the twist in each successive operation being in a different direction to that in the one preceding it, so as to preserve as largely as possible the parallelism of the fibres. Thus "the prepared fibre is twisted or spun to

the right hand to form yarn; the required number of yarns receive a left-hand twist to make a strand; three strands twisted to the right make a hawser, and three hawsers twisted to the left, a cable.

Now in all the large modern rope manufactories, machinery accomplishes the various operations more expeditiously and perfectly than was possible in the old rope-walks, and since machine spinning allows the whole length of the fibre to be extended at full length, and the full strength of the material to be obtained, ropes made by machinery are found to be twenty-four to thirty per cent stronger than those made by hand, this being due to the superior evenness which ensures an increase of tensile strength and pliability. The weight and strength of rope varies according to the quality of the hemp of which it is composed. The size of rope is designated by its circumference and the length by fathoms.

The operation of rope-making in the ancient rope-walks was as follows: "The hemp being first hackled or combed, the spinner fastened a bundle or 'strike' of hemp around his waist, with the bight or double in front and the ends passing each other at his back; a number of fibres were attached to the hooks of a whirl; the spinner then walked backward down the rope-walk, paying out the hemp from the skein with one hand, and supporting the spinning yarn with the other hand, covered with a piece of wetted cloth. When the end of the walk was reached, or the yarn was sufficiently long, the end of the yarn was taken off the hook on the whirl and was wound on a reel. The next process is warping the yarns or stretching them to a given length in order that they may, when formed into a strand, bear the strain equally. It is at this stage that the yarn is tarred by hauling it in skeins through a tar kettle.

"In the next operation, which was technically termed 'laying,' two or more yarns were attached to hooks on a whirl, so that when turned the yarns were twisted the contrary way to the twist given them in the spinning. Thus were the strands made, and to make a rope three of them were affixed to three hooks at one end, each strand on a different hook, and all three strands were affixed to one hook at the other end; the single hook twisting one way and the three others the reverse way."

Such was the state of the industry when in 1642 a rope-walk was set up in Boston, only twelve years after the town was founded, when it was in truth "rather a village than a town, consisting of no more than twenty or thirty houses." Before that nearly every kind of rigging and tackle for vessels had been brought from England.

It is probable that the building of the first ship in Boston, a vessel of 160 tons, called the "Trial," inspired our forefathers with the idea of fitting the new craft with rigging made in the land of her birth; at any rate, at that juncture it was that one John Harrison, a ropemaker of Salisbury, England, was invited to come to Boston "on motion of some gentlemen of this town." He responded to these overtures and set up his

rope-walk on land pertaining to his dwelling on Purchase Street, at the foot of Summer Street. The "walk" was ten feet, ten inches wide. Posts were set up, to which the ropes and cords were suspended, and in the open air the work was carried on. Harrison enjoyed a monopoly of this business up to 1663, when permission was granted John Heyman to "set up his posts," but with liberty only to make fishing lines; even this license being revoked when it was found that it impaired Harrison's means of making a livelihood for the eleven persons dependent upon him. Hemp also was hard to be procured, which was another reason for circumscribing its manufacture. After Harrison's death, rope-walks increased in number, and for sixty years there were in the North and West ends some fourteen of them, so that in 1793 the industry was thriving, this being partially due, no doubt, to the fostering bounty of the General Court. It is recorded that in 1794 "over fifty men were employed (in Boston) in this work alone;" but, in that same year, seven of the rope-walks were destroyed in a great fire, and the selectmen decreed that no more should be built in the heart of the town. The work in these ancient rope-walks was mostly done by hand, in some cases supplemented by horse or water power; rope-makers were legally apprenticed, and there was, as in all the manufacturing trades, great opposition to the introduction of even the simplest machinery.

But it must not be thought that Boston or even Massachusetts held a monopoly of this primitive industry. Rope-walks there were at Nantucket, three of them; there was one at Newburyport, one at Castine, Me., while a large establishment was founded at Portland, Me., by Samuel Pearson. His two sons, Samuel, Jr., and George C., learned the business with their father and afterwards founded the Suffolk Cordage Company, which later became the Pearson Cordage Company, one of the largest factories in the country. This Samuel was the author of many inventions in rope machines and in regulators for spinning. After his death, his son, Charles H. Pearson, who had been identified with his father's business, became connected with the Boston Cordage Company, and still later with the Standard Cordage Company, now insolvent. In 1810 there were 173 rope-walks in the United States, and these were scattered all over the country.

In 1820 Bourne Spooner, with Caleb Loring and others, brought about the incorporation of the Plymouth Cordage Company, at Plymouth, Mass.; but it was not until 1832 or 1834 that machines for rope-making were introduced into Massachusetts, and it was then called "patent cordage" to distinguish it from the hand-made product. At first the machines were run by water power, but in 1837 the first steam engine was put into the Plymouth Cordage Company's mills, and steam was doubtless made use of by other companies about the same time. In California the industry was established by Mr. A. L. Tubbs, who bought most of the machinery in

one of the old Boston mills and shipped it to the Pacific Coast, and later controlled the two or three factories located there.

But these comparatively modern firms, though springing from the ancient rope-walks, as time passed and the industry progressed, were doubtless early equipped with all that was best and latest in improved methods and machinery, some account of which must be noted here.

Rope-making, as it was known to our immediate ancestors, had been going on for centuries with little or no change up to that period, when Dr. Edmund Cartwright invented his "cordelier" in 1792.

The "Cordelier" was improved and brought to a practical condition by Captain Huddart in 1805, and to him is ascribed the honor of many devices to further aid in the manufacture of ropes and twines; but though many improved machines have been produced in both America and Europe, the fundamental principles were embodied in Cartwright's invention. By 1820 rope-making machinery was in practical operation in England, though hand rope still continues to be made. Even now, though making rope by hand is almost a lost art, there are two rope-walks in the United States where it is still practised. One of these is at the Navy Yard, Charlestown, Mass., which is the only rope-walk owned by the United States Government. The products made there are used principally for serving wire rope, rigging and other ropes needing protection, and are all tarred. The serving cords are, mainly, marline, houseline, hambroline, round line and two and three yarn-spun yarns. The manner and process of manufacture differ in no wise from that we have described as being practised in the old rope-walks. At the Charlestown rope-walks three kinds of hemp are used, Russian, Manila and Kentucky.

It is forty years or more since hand rope-making was at its zenith in the United States. One man can now do the work it formerly employed eight men to perform; that is, one man can attend to eight machines, each doing the work of one man. A complete set of rope and twine-making machinery in a modern rope factory consists of a heckling or combing machine, spreading and drawing frames for line yarns, and carding engines and drawing frames for tow. These machines are very similar to those in use in flax manufacture, the heavier yarns for rope-making being spun upon a gill spinning frame, such as the automatic spinner invented by John Goode, of New York City, which embodies a self-feeding motion, so that when the amount of material presented to the machine lessens, the speed declines, and when it fails, the machine stops. Goode also contributed several other important and effective machines to the rope-making industry.

The compound rope machine of Glover & Guiltimans practically gives three machines in one, and constructs three-strand ropes up to three and one-half inches. "The yarns being wound round on the bobbins in suitable numbers, according to the size of the rope to be made, they are

from each bobbin threaded through a head runner—register plate of six holes—and gathered at a die, at which they are enclosed into strands, there being a separate die for each of the three strands. The strands being formed, they are then threaded through a manhead receiver of three holes, and immediately closed at the main closing die into finished rope, the finished rope being drawn through the die by means of strong hauling-offdrums, and ultimately wound on a storage creel."

In 1878, after the invention of the self-binding harvester, the large mills were established. Sewell, Day & Company, who had been in business since 1835, built one in Boston, as did the Pearson Cordage Company and J. Nickerson & Company; other large factories were those of Weaver, Fitler & Company, which later became Edwin H. Fitler & Company, of Philadelphia; Plymouth Cordage Company, Plymouth, Mass.; Hingham Cordage Company, of Hingham, Mass.; New Bedford Cordage Company, of New Bedford, Mass. (this company dated from 1842); Baumgardner, Woodward & Company, of Philadelphia; J. T. Donnell & Company, of Bath, Me.; William Wall & Sons, of New York City; Lawrence Waterbury & Company, Tucker, Carter & Company, Elizabethport Steam Cordage Company, all of New York; Thomas Jackson & Son, of Easton, Pa.; J. Rinekes Sons, of Easton, Pa.; and John Bonte's Sons, of Cincinnati. These firms were situated mainly at the Atlantic seaports, but several circumstances, namely, the decline of American shipping, the invention of wire rope for standing rigging, and the invention of the self-binding reaper, with the consequent demand for binder twine, brought about a change in the cordage business, and factories rapidly multiplied in the West and other agricultural centres of the United States, Akron, Peoria, Manisburg and Xenia taking a very important part in the business. There are now cordage manufactories all over the country, Massachusetts and New York leading the States in amount of capital employed in this industry.

The various materials from which rope is made stand in the order of their importance as follows: Hemp, which is the product of a plant known botanically as canabis sativa. It is an annual native to Asia and cultivated in Europe from the earliest historic times as a coarse fibre, fit only to make ropes and twine, but for its finer uses was not known in Europe until comparatively recent times. History cites as a curiosity two chemises made of hemp which belonged to Catherine de Medicis. The fibres of hemp, tough, durable and elastic, are admirably suited for making cordage and canvas for shipping, and large amounts of it are so employed. It is cultivated for this purpose in almost all the countries of Europe, Poland and European Russia being the chief exporting countries; French, English and Irish hemp are much esteemed in the market, but the quantity grown in those countries is inconsiderable. Italian hemp is better known, of which there is a very fine quality known in commerce as "Italian Garden Hemp," the fibre of which is eight or nine feet long.

In Great Britain, the supply of hemp for the great amount of cordage there manufactured was largely obtained from Russia until the time of the Russian War, when the consequent scarcity and the great increase in the price of Russian hemp caused the manufacturers to turn their attention elsewhere, which resulted in the substitution of better and cheaper fibres for the purpose.

Sunn hemp is the product of a leguminous plant native to India, the crotalaria juncea, and is not true hemp (cannabis sativa). Its fibre, of which millions of pounds are shipped annually, is the "brown hemp" of commerce, and is known as Madras or Bombay hemp, according to the port from whence it is shipped. The Bombay hemp is unskilfully prepared and is much inferior in wearing properties to that of Madras or Bengal, and it is therefore in less demand for shipping purposes.

American or Kentucky hemp is a true bast fibre, the product of a species of the cannabis sativa. Kentucky hemp is coarser and darker than Russian or European hemp, and is used chiefly for making various tarred goods such as ratline, marline, houseline, etc. The plants are cut and spread out to dry and carefully stacked. Later on the stacks are opened and the hemp is retted or rotted by the action of the dew and the sun. This rots the gum which causes the filaments to adhere, and causes the dry, woody part of the stem to fall away during the process of breaking which follows. The fibre is then hackled to clean it from fragments of wood, broken fibre and dirt, and is pressed into bales. Hemp was formerly a very important product in Kentucky, but of late years the industry has declined. Manila, confusingly termed "hemp," is the fibre of the musa textilis, or wild plantain, which has long been used in South America by the Indians and natives for the manufacture of rope and cloth. The celebrated circumnavigator, Dampier, thus records the process of its preparation in the Indian Archipelago over a century and a half ago: "They take the body of the tree, clean it of its outward bark and leaves, cut it into four quarters, which, put into the sun, the moisture exhales; they then take hold of the threads at the ends and draw them out; they are as big as brown thread; of this they make cloth."

In the Philippines, both the plantain and the prepared fibres are called by the name given to them by the Spanish, "Abaca." The plants are propagated from shoots and matured in two or three years, when they are tree-like in shape, and fifteen to twenty feet high, the stalk or body of the plant being composed of the separate leaf stems or "folds" growing in overlapping layers. The fibre is obtained from the bark of these folds, that of the innermost stems being superior in quality and color to that of the outer ones.

The fibrous strips are then freed from the pulp by means of a knife hinged over a block of wood. Should a smooth-edged knife be used, with a due amount of pressure, a smooth, strong fibre is obtained; this operation,

however, requires more tenacity of purpose and application than ordinarily pertains to the native workman, who too often uses a rough-edged knife and handles his material slackly, the result being a large amount of inferior fibre, which causes much trouble to the manufacturer of rope. The fibre, after being scraped, is hung up to dry, when it is tied up in bundles or hanks and carted to market. In the exporter's warehouse, it is sorted and graded into bales weighing 275 pounds, and thus it eventually reaches the cordage factory.

There is great differentiation in the quality of Manila, owing to the fact that there are more than a dozen different varieties of the musa textilis, and, as we have seen, the material is often injured by lack of care in its preparation. Manila having steadily increased in price of late years, much adulteration with other fibres and with inferior Manila has been practised in order to cheapen the production of rope. However, good Manila rope is greatly superior in strength to that manufactured from Russian hemp; the best comes from latitudes south of Manila and from several islands as far as the tenth degree. The plan now adopted in manufacturing rope from Manila hemp may be briefly described: "The first floor of the factory is occupied with the dressing machines, three of which are cylinders of wood covered with points of iron, two inches in length, distant from each other about one and one-half inch. These first open the fibre, which then passes to another machine, under a cylinder of much larger diameter, of which the points (cards) are smaller and placed together. By this the fibre is separated into a finer thread, and divested of the woody or refuse particles.

"After this preparation, the hemp passes between two iron cylinders, which compress it very strongly. From thence it is conducted to a smaller machine, which gives the first twist, and winds it on a bobbin of about six inches in diameter. The dimensions of the cord are increased or diminished by means of an iron screw, which adjusts the diameter to the hole through which the fibres pass to the required size.

"The demand for Manila rope is ever on the increase, and immense quantities of Manila hemp are constantly shipped from Manila to Europe and America. The cultivation of the plantain from which it is obtained has been largely increased of late years in the Philippines and also in the northern part of Celebes and in the Island of Leyti. The greater part of the Manila grown in the Philippine Islands is used by the United States, though a considerable portion goes to Great Britain."

Next in importance to Manila is the sisal hemp of commerce, the fibre of the Agava rigida, variety sisilana and variety longifolia. The common names applied to sisal hemp are henequen or jenequen, sosquil, cabulla or cabuya, the latter being the Central American names. The agave is a cactus-like plant and is cultivated, to a very considerable extent, in Mexico, particularly in Yucatan, the sacci or white agave being the kind principally

grown in that locality where the development of the henequen industry has given rise to great prosperity and progress and has brought about the construction of several railways, notably that which runs from Murida to the port of Progress. This was the first line, but it soon proved inadequate to the demands made upon it in the freightage of the henequen prepared for export, and a second line was built, and these two lines are reported to be, for their mileage and capacity, the most profitable freight railways in the world. When the hemp is taken off the cars at Progress, which has become quite an important seaport, it is shipped on to steamers of the Ward line, which, twice a week, leave there laden with henequen or sisal for Cuba and New York, almost the total exportation of sisal being through Progress.

Agave sisilana has been introduced into Jamaica, where it can be successfully grown. By the native Mexicans the fibre of this plant has been used for many centuries for the purposes of manufacturing cordage, mats and cloth; but the demand for binder twine and the employment of American capital has made the cultivation and preparation of sisal a very important industry. Labor-saving machinery in place of hand labor and the rude primitive methods of the natives have brought the business up to date, and many sisal cultivators have made large fortunes within the present generation.

In propagating the fibre-yielding agaves, the suckers are set out in rows, the weeds being cleared out from the field and the plants tended once or twice a year. In the fifth year some of the leaves ripen and are ready to cut; then the natives go through the fields and cull these leaves, which are the outer ones, free them from their thorny edges and tie them up into bundles of fifty, and by means of trains, drawn on portable tracks by oxen, convey them to the cleaning mill. The plant continues to afford a supply of leaves for a period of from ten to twenty years, when the plant flowers and dies. (See Plate 12.)

The length of the fibre is only about two to four feet; in color it is a yellowish white with sometimes a slight tinge of green. It is harsher and less flexible than Manila and apt to show "splints" in the rope.

In former times the fibre was extracted by the simple and primitive manner of beating the leaf on a block with a club or mallet, and afterwards scraping it on a bench or a smooth log or pole with one end on the ground and the other breast high. They employed a narrow piece of board with a triangular notch in the end, which was brought to an edge, and held nearly perpendicular when used. The leaf was laid on the pole, held with one hand and scraped with the other. In order to get rid of the gum more readily, the beaten leaves were generally soaked either in water or in mud till they fermented; but from the nature of the gum, even a barely appreciable amount of fermentation stained and weakened the fibres, though the steeping materially facilitated the cleansing of them; indeed, the difference between the two methods then in vogue, that of allowing the leaves to ferment and that of at once beating and scraping the fibre from the leaves

when fresh, was such as to render the fibre obtained in the latter way four times more valuable than the fibre treated by fermentation. The operation is now effected by machinery. The sisal is carried from the fields to the cleaner-house, where the pulp is cleaned from the fibre, the bundles of leaves being taken up on an elevator and passed along a carrier, which feeds them into the machine where they are held in place by a grip-chain, while wheels formed for that purpose scrape the fibre from them; as it passes out of the machine it is hung up to dry in the sun, and, this being thoroughly accomplished, the fibre is taken to the press and made into bales weighing about 350 pounds each. It is chiefly used in the United States for binder twine, lath twine and tying cords for all kinds of purposes, such as bundling laths, shingles, lumber, kindling wood, leather hides, cooperage stock, nursery stock-tying, grain sacks, and bales of textile goods, and for further almost innumerable purposes. It is occasionally used for the purpose of admixture with hemp for the manufacture of second-rate Manila rope when its presence can almost always be detected by the appearance of rough fragments or splints; nor is the rope thus adulterated by any means as strong as that made from pure manila. When the fibres or filaments are obtained from the outer leaves of the plant they are very strong and coarse and well adapted for cables, cordage, ropes, canvas, sacking, the warps of carpets and for every description of this class of manufactures where strength is the main desideratum; it is also more durable than hemp, and ropes made from it are lighter and more pliable than hempen rope and do not require tarring, an operation which greatly weakens hempen rope. It also bears the alternations of dryness and moisture with little injury; the difference in hygrometric is considerably in favor of the agave ropes. "Cables made from this material," says P. L. Simmonds, F. R. C. I., a British authority on the subject, "are acknowledged by the Admiralty Board to be much superior to those made from hemp."

All the species of agave yield a white but somewhat brittle fibre possessing useful qualities. Ropes are made in the Canary Islands from agave fibre. That of agave Americanus is mentioned by Humboldt, the great traveller, who tells of its strength by describing a bridge where the distance of 838 feet was spanned by ropes made of the fibre of this plant, which actually formed the groundwork of the roadway of the bridge.

Pita is the fibre of the Brometia silvestris, which abounds wild in the state of Oaxaca. It somewhat resembles ramie, which we will describe later; it is, when made into rope, one-sixth lighter than that made from hemp, and is therefore greatly esteemed for the rigging of vessels, since it causes a sensible reduction in the top weight, and effects a saving in the first cost. It has a second merit—that of contracting less than hemp. From comparative trials made at the French dockyard, at Toulon, we again quote Mr. Simonds: "On ropes made from this fibre and from hemp,

the following results were obtained, both being immersed in the sea for six months and exposed to the atmosphere for the same time:"

Pita.	Weight supported, lbs.	Hemp.	Weight supported, lbs.
Plunged in sea......	3,810	Plunged in sea......	2,538
Exposed to air......	3,724	Exposed to air......	3,022
Plunged in sea......	1,935	Plunged in sea......	617
	9,479		6,167

Monsieur Chevremont, a noted Belgian engineer, who had closely studied the subject, thus wrote: "Ropes made from the pita possess a greater average strength by four times than those made from hemp of the same diameter and manufactured by the same process. By the operation of tarring, ropes of hemp lose nearly a quarter of their strength, while ropes made from the pita, from their nature are exempt from this operation (their natural gum acting in lieu of tar) and their smooth surface protects them from wear by friction; they are employed with the greatest success to communicate rotative motion by means of pulleys, and last, for this purpose, ten times longer than hempen ropes of the same diameter. They have much less rigidity or stiffness, and it is well known that this stiffness in ropes employed for machinery offers a resistance which must be overcome, and therefore acts disadvantageously as a loss of power."

Compared with ropes of hemp, the specific gravity of pita is as nine to fifteen. It is therefore easily seen that the ropes must also be lighter than hempen ropes, which makes pita rope particularly desirable for use in collieries and for other mining purposes.

Up to the present time there is no machine in existence adapted to the preparation of this fibre, and the Mexican Indians obtain it by the most primitive methods. Pita begins to produce the second year after its planting. The leaves are longer than those of sisal, and as the yield is two pounds of fibre from twenty leaves, each six feet long, and there are two or three cuttings a year, each plant produces a large quantity per annum.

Aloe fibre is largely cultivated in Russia, whence it is exported to France principally, where it is used for making hats, cordage, paper mattings, etc. The process of manufacture is simple and inexpensive, the machinery being solely an engine of four horse-power, which revolves a pair of cylinders on a system of stampers or beaters, while near at hand are the metal or stone receptacles, which are used for soaking or washing. The leaves which are cut green are passed through the machine and crushed without destruction of the fibre; they are then left to soak for six or eight hours; at the end of that time the leaves are disintegrated. Thirty leaves

of aloe, six feet long each, yield on an average two pounds of fibre. This is packed at St. Denis in hanks and pressed in sacks.

Mexican grass or ixtle or istle is the fibre of the maguey manso and maguey mexic, and is largely in demand as a substitute for bristles in cheap nail and other brushes; it is also used by Americans and Germans in the making of cordage and bagging. It also comes into requisition as an adulterant of sisal. It is extensively used in the Isthmus of Tehuantepec and the higher lands of Mexico.

Ramie, the fibre of Bœhmeria, a genus of the natural order Urtica or nettle family. The Urtica nivea is the species most used; it is a shrubby plant similar to the common nettle, the bast, or inner layer of the bark, containing the fibre. It grows naturally and is cultivated in China under the name of Schon Ma, and has been used extensively in that country for many centuries for the manufacture of ropes, twine, nets, sewing thread and cloths. It also grows naturally and is cultivated in Sumatra, Java, Siam, Burmah, Assam, the Sunda Islands, Lahore and other parts of the East Indies; it was formerly wholly exported from China under the name of Rheaa grass, but it is now grown in Algeria, Egypt, Cape Colony, and in Louisiana, U. S., where it is known by the name given it by the Malays—ramie; also in Mexico, Guatemala, Colombia, Brazil, the Sandwich Islands, the West Indies and in the Transcaucasia, but cannot be successfully grown in Europe since it requires a warmer climate.

The strength of this fibre is quite extraordinary, being about double that of hemp, which brings it into prominence as a desirable material for the manufacture of ropes, cables, twines and thread for which in China it has long been the common material. A few years ago the war department of France introduced this fibre for the manufacture of cables for war balloons and for the making of gunpowder sacks.

Jute is the fibre of the Corchorus capsularis and C. olitorius; it is largely cultivated in Bombay and is used in the cordage industry, but chiefly for bagging and baling. Another Indian fibre, the moorgha or marool (Sanseveira zeylanica), is remarkable for its pure white color; a line four feet long made of this fibre bore a weight of 120 pounds, when a cord, the same size, of Russian hemp broke at 105 pounds. The former, after 116 days' maceration, bore a weight of thirty pounds, when the hempen rope was completely rotten. Large quantities of the fibrous bark of the lime tree are used in Russia for cordage and mat-making purposes, there being very extensive forests of the tree in that country.

Most of the tropical countries abound with valuable textile plants, some of which are at present looked upon as troublesome weeds. Some of these are ligneous plants and will produce annually two crops of shoots and require no machinery in the preparation of the fibre for the market.

Many plants of the Hisbiscus family yield useful fibre; the natives of Australia manufacture durable twine for their nets, etc., from two

species of this plant. H. hetorophyllus is one of the straight-growing shrubs, with strong, fibrous bark, that bear the name of "cordage trees" in Tasmania. The inhabitants of Tahiti manufacture clothes, ropes and matting from the bark of H. lilaceous. Mahobark Hisbiscus elatus furnishes a very strong but coarse fibre, largely used by the natives of Demerara.

In India also many of the malvaceous plants are largely cultivated for their fibres, which are highly esteemed for manufacturing purposes. Hisbiscus cannabis, which abounds in Coromandel, yields quantities of strong and tolerably soft fibres which are used as a substitute for hemp. in the Northwest provinces of India it is generally cultivated for cordage.

Several species of the grass tribe (saccharum) are employed in India for making ropes used on the rivers Ganges and Indus. Dr. Forbes Watson makes favorable mention of an Indian grass called "mouvy" (Saccharun munja) which grows abundantly in the province of Scinde, where it is used for making ropes for the native boats on the river Indus. The fibre of this plant is strong and good and is exported to England from Kurachee.

Eriophorum cannabinum, a cotton grass growing abundantly in all the ravines of the Himalayas, is plaited into the ropes of which the jhoolas or rope bridges over the large rivers in India are almost universally made.

By the North American Indians, twine bags, fishing nets and twines are made from the stalks of Apocynum cannabinum and hypericifolium, which afford an excellent substitute for hemp.

The roots of Butea frondosa and superba are made into strong ropes in India, while Sagueras rumphii affords fibre admirably adapted for cables and long cordage. In Western Africa the natives make excellent line and rope from the leaves of the wine and oil palm (Elais guinsensis). It furnishing the whole of their fishing nets and lines. In Cape Colony rope grass (the various species of Restio) are frequently used for making cordage.

Phormium tenax, or New Zealand flax, is of a different order to common flax, which is an exogen, whilst phormium is the product of a lilaceous plant, and an endogen. There are several varieties which have long been used by the natives of New Zealand for making rope and mats. It grows abundantly as a weed in many parts of the colony. It is used as a substitute for Manila hemp, largely in the manufacture of cordage, and great attention is paid to its cultivation in all parts of the colony, where for many years immense quantities have been made into rope, and since 1864 the exportations have been very large and constantly augmenting. It has been introduced into various parts of Australia and has been successfully grown in Ireland, the west coast of Scotland and the Channel Islands. The rope made from phormium when untarred will last thirty-four per cent longer than manila, but chafes more freely and is more susceptible to change of weather. Among the fibrous substances used

in the East we mention incidentally split rattan cane (calamus), which is used for cables, which are extremely strong and durable, and have the additional quality of being so light as to swim like cork upon the sea. The plait cordage of the gomuti or ejoo fibre furnishes the entire equipment of the native shipping, and the large European ships in the East use cables made of it, which are noticeable for their tenacity and durability.

Coir is one of the most approved materials for cables, owing to its strength, elasticity and lightness. Salt water affects it very slightly. Before the introduction of chain cables, most of the vessels navigating Indian seas were furnished with cables made of this material, which is made from the fibrous outer covering of the cocoanut. Coir and coir rope are shipped from India to the extent of over 10,000,000 pounds annually. Ceylon is the principal place of its preparation, but from Cochin comes the best quality of yarn, and many thousand hundredweight are annually shipped from there.

Among modern nations cotton was first employed for making rope in the United States, though it must have long been used in India for cordage purposes. In this country it is made into rope for rigging, tow lines, cords, twines, fishing nets, lines, etc. The cotton chiefly used is long staple Macon-Georgia, and it is made on special machines. Cotton has many advantageous properties when considered in the light of a cordage material, being capable of a tighter twist and less susceptible to friction than is hempen rope, also it is more pliable and runs more freely through the blocks, the fibres being laid together more compactly and with greater tension.

Esparto cordage is made in Spain and largely exported to France, Italy, Holland, Portugal, the United States and England, and the Spanish marine and mining industries use an immense amount of cordage made with esparto, which costs about fifty to sixty dollars a ton.

Hide ropes are still made to some extent, the operation being pretty much the same as that shown on Egyptian tablets dating back many thousands of years, the strips cut from the hide being plaited together, according to the size of the rope required. The rope is then submitted to the action of a solution which has the effect of rendering the animal substance soft and pliable and at the same time preserving it. These ropes form a good substitute for a chain, and are used for hoisting purposes in warehouses and mines. Sailors prefer hide for tiller ropes because it does not rattle and is not apt to break so suddenly as a chain. It is also preferable to hemp or Manila rope because it is unaffected by humidity or extreme dryness; it is also less cumbersome and lighter, its tenacity being tenfold greater.

At a time when, owing to complications with Russia and a failure of the hemp crop, the British admiralty was paying four hundred dollars a ton for hemp, Mr. G. W. Binks, a foreman ropemaker in the Woolwich

Dockyard, invented wire ropes and cordage. Mr. Binks, who had been in the employ of the government for thirty years, under its direction made innumerable experiments with various cordage; nothing, however, seemed to possess the many excellent qualities of hemp. In his leisure moments at home he conceived the idea of twisting together fine wires to form a rope, of which he made a specimen and submitted it to the admiralty officials, who gave it no approval. Step by step against many adverse circumstances, the undaunted inventor worked his way to success, and iron wire ropes, first conceived and used for the standing rigging of ships, are now put to innumerable uses—ships' standing and running rigging; submarine telegraph cables, suspension bridges, guide incline, and flat ropes for mining purposes, special forms of rope for engineering, pneumatic telegraphs, traction ropes for tramways, steel plough ropes, coulippe ropes for transport of sugar canes, etc., tent stay ropes, ropes for hoisting purposes, tow ropes, endless driving bands, bullock traces, telegraph running and stray strand, fencing strand, scaffold ropes, clock lines, clothes lines, sash lines, lightning conductors, gilt and silvered cords for hanging pictures, and many other applications might be enumerated. These ropes are made with hempen cores or without, and a scientist writing of them says: "Many considerable steps in modern progress, such as submarine cables, suspension bridges, etc., could not have been effected without the aid of this principle." The methods and machines used in manufacturing this rope are largely similar to those employed in twisting fibres into rope. This invention resulted in a decrease in the cordage industry when it was adopted for the standing rigging of ships, a decrease which happily was more than offset by a new demand for binder twine for use in self-binding reapers, invented about that time.

We now come to the statistics of the cordage and twine industries of the United States, and we find that in 1880 there were 165 establishments, with an aggregate capitalization of $7,140,475, with products valued at $12,494,171; in 1890 the number of establishments had decreased to 150, with a capitalization of $23,351,883; value of products, $33,312,559. In 1900 there was a further decrease of the number of establishments, due no doubt, as was the decrease during the previous decade, to the merging of several concerns into large corporations; thus in 1900 there were 105 establishments manufacturing cordage, with an aggregate capital of $29,275,470; the product of the manufacture as a whole amounting to $37,849,651. During the period from 1900 to 1905, the progress of the industry was greater than at any previous time in its history. Capital increased in round numbers 27 per cent; number of wage-earners, 11 per cent; wages paid, 30 per cent; cost of materials, 35 per cent, and value of products, 35 per cent; so that in 1905 there were 102 establishments with an aggregate capital of $48,017,139.

In 1900 the product of binder twine was 165,609,429 pounds; the

product of rope 137,546,204 pounds. While in 1905 the binder twine manufactured amounted to 191,796,047 pounds and the rope to 200,824,-974 pounds.

It is interesting to note that, in 1824, the Senate of the United States passed a resolution inquiring as to the quantity of cordage manufactured from hemp of domestic growth that had been used in the American Navy since the War of 1812, and elicited the information that only 182 tons of Kentucky yarns, and cordage manufactured from Kentucky hempen yarns, were contracted for and delivered in 1813 and 1814; namely, "one hundred tons of cordage contracted for by Matthew L. Davis to be manufactured from Kentucky hempen yarns and delivered in New York in 1813; fifty tons of Kentucky yarns contracted for by Richard Pindell and H. Clay, delivered at Baltimore in 1814; thirty-one tons, seventeen hundredweight, twenty-seven pounds of Kentucky yarns contracted for and delivered at New Orleans in 1813 by W. Garret."

It was found that the discrimination against American hemp was due to the practice of dew-rotting the hemp instead of water-rotting.

TEXTILE MACHINERY

BY GEORGE O. DRAPER

A history of the development and manufacture of textile machinery in this country would require several volumes to do it full justice. Any brief sketch must properly be limited to the earlier and later history, since those whose plants have not continued active usually had but little effect on the general evolution of the industry. The earlier manufacture of textiles in this country was carried on with hand cards, spinning-wheels, jennies and hand looms, the earlier ideas all being imported from England. Richard Anthony (of Rhode Island) and Daniel Jackson appear to be the first textile machinery manufacturers on record, as they made a spinning jenny in 1787 containing thirty-two spindles, Moses Brown, an efficient financier, of Providence, R. I., becoming interested in an attempt to run the same by water power. Early attempts were made to introduce models of important inventions from abroad, but the English laws were very strict, it being their intent to prevent other countries from profiting by disclosure of their new processes. Tench Coxe, who held government positions under Washington and Jefferson, attempted to get a full set of models of the Arkwright inventions. They were seized before shipment. Coxe then offered a reward in Philadelphia papers for the introduction of the improved machines, and it was through a notice of this advertisement in an English journal that Samuel Slater was prompted to immigrate. The Hon. Hugh Orr, of Bridgewater, Mass., had meanwhile induced Alexander and Robert Barr, of Scotland, to come to this country and reproduce the English inventions, the Massachusetts legislature in 1786 granting the sum of two hundred pounds to assist them in completing the machinery; but their efforts were futile.

The first cotton factory of record in this country was started in Beverly, Mass., in the fall of 1787. Moses Brown was also interested in this project. Samuel Slater, financially assisted by the firm of Almy & Brown, began the manufacture of the approved English machinery in 1789, and laid the real foundation for the cotton spinning industry of the United States. The word "spinning" is used advisedly, for it was not until Francis C. Lowell developed a successful copy of the English power loom that the weaving industry of this country was fairly started. In 1816 it was said that there was hardly a cotton spindle running in the

United States, since overproduction of the spinning machinery had glutted the market, the hand looms being unable to take care of the product.

The Whitney cotton-gin was the first important textile invention credited to an American. Eli Whitney's patent was taken out in 1794; but there is some dispute as to whether the machine shown in patent of Hodgen Holmes in 1796 does not better disclose devices which have been successfully developed for commercial practice. It is interesting to note that other Southerners were active in machinery lines, the cotton mill of Michael Schenck, built at Lincoln, N. C., in 1813, being completely equipped with machinery all made at Lincolnton. It is shown by records that this shop made picking, carding, roving and spinning machinery. In 1813 Francis C. Lowell, who had examined power looms in England, started, with Patrick T. Jackson, to develop a practical weaving loom. They were assisted by Paul Moody, a most efficient mechanic, who later made important modifications in other textile machinery. The English double speeder was introduced in this country through the efforts of William Mowry, who secured access to an English mill, accompanied by a clever mechanic named Wilde. English displeasure was manifested by an infernal machine shipped to this country, addressed to "the person who first introduced the double speeder in America." The package slipped from a crane on the wharf, exploding without injury to anyone.

The American citizens who started this great industry in this country were undoubtedly urged by patriotic motives; yet the ethics of their associates are somewhat open to question. There is no doubt but that we, as a nation, profited against their will from the inventions of men who wished to keep their ideas for use by their own countrymen, and had there been sufficient and proper patent protection in both countries, they could undoubtedly have done so. Those of us who realize the helplessness of inventors or introducers when unassisted by capital, can safely credit Moses Brown with being the true father of cotton manufacture in this country, and make no great mistake in giving second place to Francis C. Lowell. The cotton industry depended on the preliminary development of the manufacture of the machinery in which they were vital factors. It is interesting to note that the descendants of both Brown and Lowell are still largely interested in many branches of the textile industry.

There is little of record regarding the machine shops in which the earlier cotton machinery was made, because the machinery was usually constructed by the corporations owning the cotton mills, either in the basements of the mills or in buildings adjoining. In 1816 a Scotch mechanic, William Gilmour, brought to this country patterns of the most recent loom construction. These patterns had been shipped here by way of France in small fractional pieces, as small metal ware, requiring much of patience and perseverance to rearrange the parts in proper sequence. Looms were constructed under Gilmour's supervision and operated at

Lymansville in 1817. The manufacture was continued by David Wilkinson, who had also forged the iron work and turned the spindles and rolls for Slater's first machines. The firm of Pitcher & Guy continued the manufacture of Gilmour's looms, together with cards, mules and other machinery. It is interesting to note that many of these earlier manufacturers were ancestors of those now most prominent in the textile machinery line. Joseph Brown and Otis Pettee took out a patent on a speeder in 1813. Ira Draper patented his first temple in 1816. Thomas J. Hill was associated with Samuel Slater himself in establishing the Providence Machine Company, still active in the trade. The Jenks family, of Pawtucket, have been associated with the manufacture of cotton machinery since its earliest introduction, Stephen Jenks manufacturing muskets in 1775 and forging mule spindles in the same shop as soon as they were in demand. Paul Whitin purchased an interest in a shop on the Mumford River in 1794, though the actual production of cotton machinery did not begin there till about 1830. William Mason built power looms as early as 1829. In 1833 he brought out his first spinning frame, and in 1842 his self-acting mule. The present plant of the Mason Machine Works was started in 1845. The Franklin Foundry Company were building mules as early as 1853. William Crompton invented a pattern surface fancy loom in 1837. The business was continued by M. A. Furbush and George Crompton, who later divided the business, Furbush moving to Philadelphia. The Crompton Loom Works later became consolidated with the Knowles Loom Works, which also has taken in the Stafford Loom Works, the Gilbert Loom Company, and, more recently, the Crompton-Thayer Company, thus controlling the greater proportion of the manufacture of fancy woolen and worsted looms, carpet looms, etc., and also competing strongly in the plain cotton loom field. The Saco Water Power Company, of Biddeford, Me., now consolidated with the Saco & Pettee Machine Shops, was organized in 1841. The Pettee Machine Works were founded by Otis Pettee, and that company has built cotton machinery at Newton Lower Falls since 1823. The Pettee Machine Works was organized in 1880. The Amoskeag Machine Shop, of Manchester, built cards as early as 1841. The Lowell Machine Shop was building cards in 1845. The Draper industries, though starting with Ira Draper's inventions, were not definitely located till after the formation of the Hopedale Community in 1842. The Draper Company in 1897 combined the well-known firm of George Draper & Sons with the Hopedale Machine Company, the Dutcher Temple Company and the Hopedale Machine Screw Company, also taking over the American rights of the Northrop Loom Company and the agency for the Sawyer Spindle Company. William C. Davol, of Fall River, arranged to duplicate the Roberts mule in this country and introduced such machinery as early as 1847. Mr. Davol also invented improvements himself in cards, spindles and drawing frames. The Kitson Machine Company originated

with Richard Kitson at Lowell in 1849. The Howard & Bullough, American Machine Company, started with the formation of an American Company by English interests in 1894 to reproduce certain lines of English machinery.

In the woolen and worsted line we have such old-established concerns as the Davis & Furber Company, of North Andover, and George S. Harwood & Sons. The Lowell Machine Shop has in recent years taken up the manufacture of a full line of worsted machinery. The Smith and Furbush Machine Company, of Philadelphia, make a very full line of woolen machinery.

In many lines manufacture has been practically consolidated, so that one concern produces by far the greater proportion of the product. Thus the bobbin industry is now largely controlled by the United States Bobbin & Shuttle Co.; the Emmons Loom Harness Co. controls the largest trade in harnesses; the National Ring Traveller Co. the ring-traveller business, and card clothing is largely controlled by the American Card Clothing Co. Dyeing, bleaching and finishing machinery are in a field by themselves, being supplied by such concerns as H. W. Butterworth & Sons Co., of Philadelphia; Phenix Iron Works Corporation, of Hartford; Philadelphia Textile Machinery Co., etc. There are also many concerns who stick to their own patent specialties, such as the Barber & Colman Co., of Rockford, Ill., introducing their most ingenious warp tying-in machine; the American Warp Drawing-in Co., operating on an entirely different principle; the Stafford Company, of Readville, who introduce an automatic shuttle-changing loom; the American Moistening Co., who supply humidifying apparatus for textile mills; the Dickson Lubricating Saddle Co.; the Whitinsville Spinning Ring Co.; the Easton & Burnham Machine Co., of Pawtucket, who manufacture spooling machinery and spindles; the Universal Winding Machinery Co., winding yarn on cones and in conical and cylindrical form by patent process; the Foster Machine Co., also making winding machinery; the T. C. Entwistle Co., making warpers and card grinders; the Woonsocket Machine & Press Co., manufacturing fly frames and wool-spinning machinery; the Metallic Drawing-Roll Co., who introduce a substitute for the leather-covered rolls of preparatory machinery; the Litchfield Shuttle Co., of Southbridge, an old-established manufacturing concern; the D. A. Tompkins Co., of Charlotte, N. C., the only Southern manufacturer of cotton machinery, and so on through an almost never-ending list, illustrating the magnitude of the present industry as a whole.

The subject of textile machinery in this country cannot be properly considered without reference to the importers, since there are certain distinct lines which foreign machinery manufacturers control, or in which they compete successfully with American manufacturers. The leading importers are William Firth & Co., Richards, Atkinson & Haserick, Stephen C. Lowe and Evan Arthur Leigh.

In silk machinery, the Atwood-Morrison Company, Stonington, Conn., are the largest builders of spinning machinery. Looms are made by manufacturers of looms for other purposes.

In considering textiles, it is somewhat difficult to know just where to limit the industry. As generally considered, it stops when the product leaves the mill, yet it really includes any manufacture using yarn or cloth for its finished product. The great clothing industry depends on the sewing machine, which is a purely American invention. There is a large line of knitting machinery used in the manufacture of stockings and underwear. Finishing plants and printing plants require machinery of special manufacture. The various lines cannot be accurately traced and credited without an amount of technicality unnecessary in so restricted an article as this must be.

The history of American textile machinery naturally includes that of many interesting inventions and inventors who were prominent in their time, but which have been superseded by others more successful, such as Danforth, with his cap frame, which at one time seemed destined to monopolize the cotton-spinning industry, but which is now only used in comparatively minor applications; Woodward and Wellman, with their card stripper, which has been practically eliminated, owing to the introduction of a different carding system, etc. There are also many inventors unconnected with any manufacturing concern, who deserve well of the world's praise, such as Asa Arnold, who undoubtedly invented the differential motion of the roving frame; John Thorpe, who patented the first ring and traveller; Erastus B. Bigelow, who filled an entire mill with looms perfected by his own inventions; Thomas Mayor, who put the long bolster on the roving spindle, and many others deserving of notice, but necessarily overlooked, since memory and printed record both have their necessary limitations. Such prominent later inventors as Rabbeth and Northrop will receive full credit in the chapters devoted to the special divisions of the industry to which their inventions apply.

It is hardly one hundred years since the earlier American mills were completely equipped with power-driven textile machinery. While we still owe foreigners for many fundamental conceptions, and still frankly copy many of their methods—in fact, actually import their machinery complete for many purposes—America should be well contented with having given to the world the cotton saw-gin, the ring-spinning frame, the sewing-machine and an automatic loom.

The cotton machinery industry has naturally associated itself with the larger cotton manufacturing centres; thus, in Fall River, the Kilburn & Lincoln Company build many of the looms in use, the Fall River Machine Company, however, formerly making spinning and other machinery, being now out of business. In Providence and vicinity, including Pawtucket, many machine firms started and still continue. One of the earlier pioneers, however, the James Brown Company, of Pawtucket, has lately gone out

of business. At Lowell, Taunton and Biddeford the early shops still continue. At Lewiston the former Lewiston Machine Company has been disorganized, and at Philadelphia the once well-known Bridesburg Company has long since demised. Hopedale and Whitinsville illustrate interesting industries, which have each their own town, with company control of locality, transportation facilities, etc. While many of the shops control specialized or patented features, Draper Company particularly confines its product to patented devices; in fact, this company acquires and controls more patents than any concern in any line of business in the country with similar capitalization. There are only two concerns of any nature in the country which average to develop or purchase more patents yearly.

It is mainly through improvement and adaptation to requirements that the American industry of textile machinery manufacture has been developed: for our great competitor, England, having much greater field for introduction, has developed the manufacture of textile machinery to such an extent that its cheapness of production is unrivalled, and English machinery can be introduced in the United States, in spite of tariff, on account of their superior economies, their low-paid labor being prominent as a factor. American machinery, however, is particularly adapted to American requirements, and American improvements have been so protected by patents as to eliminate foreign competition in many lines. American cotton mills, equipped with the higher-priced American machinery, and run with higher-priced labor, do compete in certain markets of the world with English cotton mills filled with the cheaper English machinery and run by more cheaply paid operatives. Had America the shipping facilities with which England is favored, its foreign banking facilities and an even chance for competition in foreign markets, we could give it severe competition in many lines which it now monopolizes.

In speaking of the development of the textile industry through use of American machinery, it is quite natural to quote more largely regarding cotton manufacture, since that is not only the chief textile industry, but other textile trades have not been as successful in meeting foreign competition or in providing an individuality in product or process. It is well known that the cotton industry in this country owes a large fraction of its mills to the financial assistance and the personal encouragement of leading machinery manufacturers. Had other textile industries the benefit of as strong machinery interests, their history might be different.

There is hardly an industry of note known to the world where progress by invention and use of improved machinery has made such strides as has the industry of textiles. The first great change by elimination of labor was in the adaptation of steam power, which made power-driven machinery possible. It is understood that a cotton-gin of to-day does work equivalent to that of one thousand hand ginners. An operative in the spinning room of a cotton mill tends from 1,000 to 1,500 spindles, each

one producing much more yarn than could be spun with the once familiar spinning-wheel. It has been figured that with hand loom and spinning-wheel, ten operatives, working ten hours per day each, could hardly together earn one dollar a month to-day, according to the present market value of their possible product. A comparison of means is well shown by evidence easily available. The entire textile product of this country is produced by less than one per cent of its population, while in Northern China it is said the whole population weaves cotton cloth during the winter, the hand looms in use yielding so meagre a product per operative.

Many attempts at introduction of improvements fail because of imperfections in the fundamental conceptions, errors in carrying out conceptions, or inadvisability in method of introduction. Thus various lines of manufacture have been started at various times, to meet with discouragement or disaster. In spite of promising experiments, the textile trade does not yet definitely recognize any acceptable substitute for the saw-gin, in spite of its known inefficiency. Cotton bales are still sold in abominable shape, and hand pickers are still necessary in the cotton fields. Picking, carding and roving machinery were standardized years ago. No one has succeeded as yet in increasing the speed of the mule or spinning frame since the adoption of the high-speed spindles. The automatic loom is the really notable factor in modern development.

Improved machinery is of vital importance to a prosperous country like America, where help is often scarce and labor high-priced. The inventor and the builder must co-operate to meet the demand, and they must be sufficiently appreciated by the mill owners, else the fundamental incentive will be lacking.

EVOLUTION OF THE TRANSMISSION OF WATER POWER

BY CHARLES T. MAIN

One of the first practical applications of water power in this country was for the old tidal mill on Mill Creek, near Boston. The development of this early water power was followed by others, wherever settlements were made and water power was available. Often availability of water power determined the location of the early settlement.

About 1725, the first water power plant was established along the Niagara River. This power was used to drive a saw-mill constructed by the French, to furnish lumber for Fort Niagara. However, the first extensive developments for industrial purposes may be said to have originated in the early part of the nineteenth century in textile mill communities. The development at Lowell, Massachusetts, in 1822, was the beginning of rapid strides in this direction. Following closely upon the development at Lowell were the ones at Nashua, New Hampshire, in 1823; Cohoes, New York, in 1826; Norwich, Connecticut, in 1828; Augusta, Maine, in 1834; Manchester, New Hampshire, in 1835; Hooksett, New Hampshire, in 1841; Lawrence, Massachusetts, in 1845, etc. The heads under which these powers were developed ranged from 14 to 104 feet.

For utilizing the energy contained in water in the form of power, many different kinds of hydraulic motors have been invented and developed. Such a motor usually consists of a wheel which is caused to revolve, either by the weight of water falling from a higher to a lower level, or by the dynamic pressure due to the change in direction and velocity of a moving stream.

The first practical hydraulic motors used were called water wheels, and the first vertical water wheels were called "Float Wheels."

Their origin can be traced back to the Chinese and Egyptians. The wheels were suspended over some river, utilizing the energy from the river current. These wheels were generally of crude construction, and developed but a small portion of the energy of the passing stream. This type is by no means obsolete, for it is yet used for minor irrigation purposes in all countries. The most important installation of this type in comparatively modern times was that employed to drive the pumps for the water supply of London about 1581.

The next step along practical lines was to confine the flow of water from the river, by means of a canal, flume or pipe, and to utilize the

energy by means of the undershot and overshot water wheels. Both of these types of wheels have also been in use for many centuries. As in the float wheel, the energy of the water is exerted in the undershot wheel through the impact due to the velocity. Although the undershot wheel was a decided improvement over the float wheel, its efficiency was only from twenty to forty per cent. The development of the overshot wheel followed closely upon that of the undershot wheel, and was a great improvement from a standpoint of economy in the use of water. Its efficiency ranged from sixty to eighty per cent. In the overshot wheel the energy of the water is applied directly through its weight by the action of gravity. The overshot wheel, however, required higher heads for its application, and in the latter part of the eighteenth century the breast wheel was developed, which was especially applicable to small falls, for which the undershot wheel had previously been used, but its efficiency exceeded that of the undershot wheel, being from fifty to seventy per cent. In the breast wheel the action of the water is partly by impact and partly by weight.

The last three types of wheels were the ones used in the early application of water power in textile mills, and their use soon spread to many other industries, especially to grist mills, many of which are still in use.

During the latter part of the eighteenth century many improvements were made on the breast wheel, among which should be mentioned that of Poncelet, whose improvements, by means of ventilated curved buckets, brought the efficiency of this type of water wheel to a point exceeding that of the overshot wheel. About this time the fly-ball governor, which had been designed and adopted as a governor for steam engines by Watt, was applied to the governing of water wheels, and by means of these governors the speed of the wheel, under varying loads, was kept sufficiently constant for the purposes for which the power was then used.

These water wheels above described, when well constructed, have given efficiencies practically equal to the best modern turbine, but on account of their large size, and the serious effects of back water and ice conditions, also on account of the small amount of power and slow speed, they soon proved inadequate, as the mills and manufactories in which they were employed were enlarged with the growth of these industries.

The first turbines used in this country were of the Fourneyron type, developed by M. Fourneyron, in France, in the early part of the nineteenth century. By 1840 many turbines of this type had been introduced in this country. The great advantages of the turbine over the old-style water wheels are as follows:

1. They occupy much smaller space.

2. On account of their comparatively high speeds, they can frequently be used without gearing or other complicated means of transmission.

3. Some types will work submerged.

4. They may be utilized under any head or fall of water.
5. They are readily protected from ice interference.
6. Their speed can be regulated within narrow limits.
7. They are cheaper for the same amount of power.
8. More power can be developed in a single unit.

About 1840, Uriah A. Boyden, of Massachusetts, made a number of improvements on the Fourneyron turbine, and several wheels of his design were installed by the Appleton Company, at Lowell, in 1846. These turbines showed an efficiency of eighty-eight per cent, and many turbines of this type were installed throughout New England.

Mr. James B. Francis, engineer of the locks and canals, Lowell, Mass., designed a wheel of this type, which was erected in the Tremont Mills, of Lowell, in 1851, and made a series of tests which he published in his book, "The Lowell Hydraulic Experiments."

In 1838, Samuel B. Howd, of Geneva, New York, patented the "inward flow" turbine, in which the action of the Fourneyron turbine was reversed, and this seems to be the origin of the American or Francis type of turbine.

In 1849, James B. Francis designed an inward flow turbine of the same general type as the Howd turbine. Two of these turbines were constructed by the Lowell Machine Shop for the Boott Cotton Mills. The turbines designed by Francis were along more scientific lines and of better mechanical construction, and this type of turbine has been generally known as the Francis turbine.

The advantages of this type of turbine were:

Increased efficiency at part load and smaller cost.

The Fourneyron turbine had a high efficiency at full load only, and on account of its low speed was too expensive.

About the same time that the Francis turbine was being developed in this country, the Jonval turbine was being introduced. This turbine was also of French design, and also showed a higher efficiency at part gate than the Fourneyron turbine, and was extensively used in this country for some time. However, both of these French types were superseded by the various forms of the American or Francis type, which proved considerably cheaper and of higher efficiency at part gate than either.

The three types of turbines mentioned are of the reaction type, in which the energy is largely developed by reactive pressure. Besides the advantage of higher efficiency at part gate already mentioned, both the Jonval and Francis turbines have the additional advantage, that a draft tube can be used with them, thus utilizing that part of the fall between the runner wheel and the tailrace. These turbines can also be submerged without interfering with the operation or efficiency, and are, therefore, very desirable where variable tail water occurs.

In order to partially obtain the result of a draft tube with a Fourneyron

outward flow turbine, Boyden developed the diffuser for this type of turbine, known by his name. Several per cent additional efficiency can be obtained with this diffuser, but it is a question whether the additional economy thus obtained will pay for the additional cost of the diffuser and the room required for it.

Up to recently, turbine designers were under the impression that reaction turbines were not adaptable to heads much over 150 feet. This belief led to the development of the impulse turbine in this country, and to the development of the action turbine in Europe. Both of these types operate under the same hydraulic principle, and the energy is developed entirely due to velocity. Both of these types have the disadvantage, when used under comparatively low and medium heads, that no draft tube can be used with them, consequently that part of the head between the runner and the tailrace is lost. This will be of considerable importance where the head is small and the level of the tailwater is variable, as the head so lost may be twenty-five per cent or more of the total. Where these types of turbines are used under higher heads, the amount so lost is of little consequence, being a very small per cent of the total head.

These types of turbines first came into prominence in the western part of this country and in Switzerland. Undoubtedly they would have been developed even if the belief that reaction turbines could not be used under high heads did not exist, because the size of units required at that time was small and some of the heads developed comparatively high. A reaction turbine, having a fixed speed, is limited as to the smallest power it can develop under any given head, so that, leaving out of consideration the question of cost, there is a practically definite point where reaction turbines must be abandoned and impulse or action turbines must be used. However, the question of cost makes it desirable to use impulse or action turbines even for sizes so large that reaction turbines could still be used.

Since the development of the electrical generator and electrical transmission of power, it has become desirable to develop large quantities of power in one place, and to develop large powers sometimes under high heads, which were previously inaccessible. It has been found economical to develop these large powers in very much larger units than had previously been used. The mechanical construction of generators, particularly of alternating current generators, makes it possible to use very high speeds even for the larger sizes, and, due to the fact that the reaction type of turbine can be operated at nearly twice the speed of the impulse or action turbine, they were soon designed for higher heads than previously and with every success.

It is a well known fact that some of the earliest turbines designed by Boyden and Francis showed as high or higher efficiencies than most turbines since built. This, however, does not mean that the turbine had not been improved since then; as a matter of fact, the improvement of the

turbine has been phenomenal. In the development of the early water powers first cost was of primary consideration.

Very few streams were developed to their full capacity, and the most successful turbine builder was the one who could market a turbine of great power and high speed at the smallest cost per horse power, providing a reasonably good efficiency could still be obtained. To show the success obtained in arriving at this result, it is necessary to mention the progress of but one builder, which is a good average among several. In 1859 he designed a turbine of 48-inch diameter, which, under 16-foot head, developed 79.1 H. P., at a speed of 102 R. P. M. By successive improvements, his 48-inch turbine, in 1903, developed 325 H. P., at a speed of 139 R. P. M.

When we consider that the power and speed of a turbine runner of fixed diameter is largely a measure of the efficiency of that runner, it will be understood that an increase of 410 per cent in power and 13.6 per cent in speed, without sacrificing the efficiency materially, is no small improvement. Since the development of large water powers during the last few years, and in plants where the total power available can be readily marketed, the question of efficiency has again become of primary consideration. In low head plants the economical solution is still often found in the use of the high-power, high-speed turbines, and this simply reduces itself to a problem of additional investment to obtain higher efficiency by means of the use of a smaller power and lower-speed turbine, and the return obtainable on the additional power gained by the higher efficiency.

In plants where the head is considerable it is generally found that a commercial speed can be obtained with a low-power, low-speed wheel, and it is thus possible to again return to the higher efficiencies of the early turbine.

In a well-designed, modern turbine, where the designer can practically choose the speed at which the turbine is to operate, an efficiency of ninety per cent can be obtained. Most modern, high-head turbines show an efficiency of eighty-five to ninety per cent in place at the power house.

Perhaps of greater importance than high efficiency in a modern plant, is the speed regulation of turbines. As has already been stated, the steam engine governor invented by Watt was successfully applied to water wheels before the invention of the modern turbine, and the regulation thus obtained was satisfactory for the users of power in those days. With the introduction of turbines, hydraulic power was used for a greater variety of purposes, in some of which comparatively close regulation was desired, and many cheap mechanical governors were invented to obtain this result. However, very close regulation of speed was not of sufficient commercial importance to permit the use of expensive governors, which would increase the first cost of the plant materially.

The success of the comparatively recent application of hydraulic power to the operation of alternators in parallel, and to the generation of

current for electric lighting, street railway and synchronous motor loads, has been largely dependent upon the possibility of obtaining close speed regulation of the generating units, accompanied with good water economy and without undue shock upon machinery and penstocks while working under extremely variable loads.

The method used for regulating the speed of reaction turbines is to restrict the amount of water flowing through the runner as the load decreases, or to increase the flow as the load increases. Three forms of gates are and have been in common use to obtain this result; namely, the cylinder, register and swivel gates.

The cylinder gate consists of a cylinder closely fitting the guide that by its position admits or restricts the flow of water into the buckets. With this type of gate the guides are fixed. When partially closed, the cylinder gate causes a sudden contraction in the vein of water, which is again suddenly enlarged in entering the runner. These conditions produce eddying, which result in decreased efficiency at part gate. This type of gate is very bulky, and for large turbines heavy counterweights must be used to operate them. They are, therefore, not well adapted where close regulation and high efficiency are desired.

Turbines with this type of gate are well adapted for driving pulp grinders or mills, where the load is practically constant and where they are operated generally at full load. They can then be regulated by hand or a slow-moving, mechanical governor. They have no advantage, however, for even this kind of load, where good head gates exist to close off the water from the turbine, the only advantage of the cylinder gate being the ease with which they can be tightly closed even with crude workmanship.

The "register gate" consists of a cylinder case with apertures to correspond with the apertures in the guides, and is so arranged that, when in the proper position, the apertures register and freely admit the water to the wheel, and is also so constructed that, when properly turned, the gate cuts off the passage completely or partially, as desired. Considerable eddying is produced by the partially closed register gate, with a consequent decrease in part gate efficiency. The part gate efficiency is not much better than with the cylinder gate, but it is more adaptable to close governor regulation. This type of gate has never found much favor in this country because the cylinder gate is cheaper and simpler.

The swivel or wicket gates have always been used in a more or less crude form, and, in their modern form, are undoubtedly the best gate, especially for moderate or high heads and where a high efficiency is desired at part gate with close regulation. When well constructed mechanically, they are as tight as cylinder gates, and they are usually so made for higher heads; but, when used for low heads, it will be found cheaper to provide good head gates which can be used to shut off the

water from the flume. The swivel type of gate is well adapted to close regulation and to obtain a nearly constant efficiency over a large range of gate openings.

The efficiency of a modern high head reaction turbine recently tested, is as follows:

Eighty per cent at half load; 85 per cent at three-quarter load, and 84 per cent at full load. The turbine tested was of 10,000 H. P. capacity, operating under 550 feet head at 375 R. P. M. It will be noticed that the best efficiency obtained was that at three-quarter load. This brings out another decided advantage of the swivel gate turbine; namely, by means of proper design, the highest efficiency can be obtained at a reduced gate opening, thus allowing for an overload capacity, such as all liberally designed generators have.

The regulation of the earlier impulse turbines of importance was accomplished by means of a deflecting nozzle. Most of these turbines operated under comparatively high heads in connection with long penstocks, and the danger of causing shocks in these penstocks by varying the flow of water in them led to the adoption of the deflecting nozzle. With the deflecting nozzle the flow of water is kept constant; if any variation of load occurs, the governor deflects the stream issuing from the nozzle, partially away from the runner buckets or farther into them, depending upon whether the load decreases or increases.

The action turbine usually has a series of nozzles, and to regulate the flow of water either one or more of these nozzles are partially opened or closed by the governor. It can be seen from the description of the deflecting nozzle that it is very wasteful if the load is variable. This, however, is true not only of the deflecting nozzle impulse turbine, but if other types of turbines are used in connection with long penstocks, where danger of water hammer or shock exists, they must also be arranged to be made equally wasteful to avoid the change in flow and consequent shock, or else provision must be made to avoid this waste. To partially overcome this waste under such conditions as described, pressure regulators and relief valves have been developed. The object of these auxiliaries is to momentarily waste some water while the load on the turbine is thrown off, and, after the new load has reached a stationary point, to either close automatically or mechanically.

Such pressure regulators, however, provide against a shock only which may occur when the load is thrown off; an equally serious result may occur when the load is thrown on faster than gravity can accelerate sufficient water to provide the turbine for the additional load. In this case a surge would occur, tending to collapse the penstock. It has been found that these surges are always considerably less than the shocks for any given set of conditions, and many cases, therefore, occur where it is necessary to provide against the shock, but not against the surge. If,

however, the surge also becomes greater than permissible, a standpipe must be resorted to. Since even with a standpipe the shock will still be greater than the surge, it may be necessary or commercial to provide both the standpipe and pressure regulator.

The conditions of installation have a marked effect on the difficulties of turbine speed governing, and often the devices above mentioned, together with additional ones, must be provided for regulation, even if not necessary, for the safety of a penstock.

If the turbine is installed in an open pit or flume, as is often done in low head plants, and has only a short draft tube and the water flows to the gates in every direction, the velocity of flow is very slow. The quantity of water which moves at a high velocity is confined to that in the runner and draft tube, and the change in velocity and momentum, due to the change of load, produces no serious effect. If, however, the turbine is an encased one, and the water must be brought to it through a long penstock, the conditions become more complicated. In this case a large amount of energy is stored in the moving column of water, and a change in its velocity involves a change in its kinetic energy, which may, if an attempt is made at too rapid regulation, leave the turbine deficient in energy; when increased power is desired, or when the power is decreased, may produce such shocks as will seriously affect regulation.

A fly-wheel on the turbine shaft can partially be relied upon to take up much of the energy produced when the load suddenly becomes less, and it will also provide energy if the turbine is deficient, due to lack of water supply. It is, of course, a commercial question which must be solved for each installation, for it may be cheaper to provide larger penstocks with consequent reduced velocities, or to provide a fly-wheel, standpipe, pressure regulator, etc., or two or more of these to get the desired regulation.

All of these devices can be applied to the impulse turbine as well as the reaction turbine, and this has been successfully done in several recent modern plants. At the present time only the Francis type of reaction turbine and the impulse turbine are being used in this country.

The reaction turbine is being successfully designed for higher heads, and experience shows that if carefully and substantially designed, such as is possible with the modern cast iron and cast steel spiral casings, and improved gate mechanisms, there is no limit as to the head for which the reaction turbine can be used.

As already stated in this paper, a reaction turbine is limited as to the smallest amount of power it can develop under any given head, so that the only limit as to the head for which it can be successfully designed is the size of the unit. This limit for a 10,000 H. P. turbine is approximately 650 feet for a normal commercial speed. However, the higher the speed allowable, the higher the head for which the same power output of turbine can be designed.

The power of the early water wheels was usually transmitted through gearing, the ratio of which was such as to increase the speed to that desired for the main shaft. From the main shaft it was transmitted to the various countershafts and machinery by means of either belts or rope drives.

Whereas, the water wheels were all designed with horizontal shafts, the first turbines were constructed with vertical shafts. Their power was usually transmitted to a horizontal shaft through bevel gears, and by this arrangement a number of turbines could be arranged to drive a single line shaft. Very often a separate canal with its turbine was provided for every separate part of the mill. When this method proved too expensive or when what proved to be a desirable location for the canal and turbines was not economically accessible for the mill, a rope drive was used to transmit the power of the turbines to the mill, sometimes several hundred yards away. The losses in transmission were often excessive, amounting to sometimes fifty per cent and more.

The development of the horizontal encased turbine, doing away with part of the canals, the water being brought to them in penstocks, was a great improvement over the vertical open-flume turbine. It was particularly adaptable to heads over twenty feet and could be located above the tail water. This made it accessible and step bearings and gears were done away with, the shafting being driven directly off the turbine shaft by means of belts. In order to obtain higher speeds for low heads, two or more runners were placed on one shaft.

Up to 1895 there were but few turbines with anything but mechanical transmission. About this time, the electrical generator, direct connected to the turbine shaft, came into general use, and soon large units were being built of this type. At first the turbines were of the horizontal type only, and under the lower heads two to six runners were often placed on one shaft, in order to increase the speed.

The old type of single vertical turbine, geared to a jack shaft, is still being used extensively in low head plants. The speed obtained on the jack shaft is usually made sufficient to directly connect the generator. Vertical turbines, with generators of the vertical type direct connected to them, have come into use of late years. Usually two or more runners are placed on one shaft to increase the speed. The object is to do away with the gearing, thus avoiding the loss in them and their upkeep, which latter is usually a considerable item. An important advantage of the direct connected vertical unit over the horizontal type is that the generator can always be placed above the highest head and tail water. This is particularly true of open-flume turbines in any case, and true of both open and enclosed turbines where the tail water varies beyond the allowable length of a draft tube.

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ELECTRIC POWER AS APPLIED TO TEXTILE MACHINERY

BY SIDNEY B. PAINE

The history of the development and growth of the textile industry is made up of many chapters, each chapter so closely related to all the others that none can be studied independently. Improvements in one process or in one machine have led to changes at other points, and thus progress has been made first in one department and then in another, with a consequent advance all along the line. It is purposed in this chapter to follow one branch of this development and to describe the conditions attending the earlier installations of the electric system to indicate the several steps in the development and application, and to show the direct and indirect effects upon the industry which have followed its adoption.

Previous to the year 1886 electric motors were practically unknown in the commercial world. Vanderpoel, Sprague, Brush and other pioneers in this field had installed a few continuous current motors, but not until 1888 or 1889 did the public acquire sufficient confidence in the electric motor to depend upon it for important installations. The alternating current motor was still, more or less, in the laboratory stage, the first polyphase induction motor being placed upon the market in 1892. Previous to that time, the use of motors in textile mills had been confined to a few isolated cases where small continuous current machines had been installed to furnish supplementary power, but no mill had placed its sole dependence upon the electric system. It was considered that it might be useful where it was necessary to carry power for any distance beyond the ordinary reach of the mechanical drive; also that, in a few cases where the drive was very complicated, possibly it might furnish a simpler solution than could be offered by shafting and belting. Even the most progressive of the mill engineers did not believe that it would ever be a serious competitor of the mechanical system, especially in new mills. The advocates of the electric system were obliged to labor for months before the first opportunity was given to demonstrate that an entirely new field was being opened up, and that, with the freedom afforded the engineer, results could be accomplished which could be attained by no other system. It is true, also, that at the beginning all of the advantages of the electric system were not fully appreciated, even by its most earnest supporters; but, as the introduction of the system progressed, new advantages were realized, and in many ways the results proved even better than its early advocates expected. In view of the above, it may

be of interest to explain somewhat in detail the conditions attending the first installation.

On July 31, 1893, a contract was closed by the General Electric Company with the Columbia Mills Company, Columbia, S. C., for an electrical equipment consisting of two 500-kilowatt, 3-phase, 36-cycle, 600-volt generators and seventeen sixty-five horsepower induction motors. The execution of this contract had been preceded by a most careful consideration of the whole subject, extending over several months, by the engineer, Mr. Stephen Greene, of the firm of Lockwood, Greene & Company. The problems presented were of an unusual nature. It had been proposed to drive this mill by water taken from the canal of the Columbia Water Power Company. This canal had been built many years before to permit the passage of boats around the rapids in the Congaree River, and followed the course of the river very closely. As there was no available mill site between the canal and the river on the property purchased by the Columbia Mills Company, the engineers had been considering two different plans of driving the mill mechanically. One plan involved the location of the wheels beneath the mill, which would have necessitated the construction of a very expensive tail race under the canal. The alternative plan considered the location of the wheel house between the canal and the river and the operation of the mill by means of a rope drive across the canal. Both of these plans would have been very costly. The General Electric Company proposed to locate the mill back from the canal, where the cost of the construction of the mill itself would be very much reduced, and to which point it would be convenient to bring a spur track from the railroad. By this latter plan the power house was to be located at a point between the canal and the river, where the best conditions for receiving and discharging the water were to be found. The simplicity of this plan immediately appealed to the engineers. At that time, however, no application of the system had been made on such an extensive scale and where so much depended upon its success. No similar installations could be referred to as examples of what could be accomplished, and to that extent the plan proposed by the General Electric Company was entirely theoretical, although it seemed the most feasible and simple solution of the problems encountered. It was not without much adverse criticism that it was finally adopted, one prominent manufacturer terming it "a most hazardous and dangerous experiment." The facts of the case were laid before three of the larger electrical companies, each of which was invited to submit a report and recommendation as to the best solution of the problem, together with a proposal based upon same. It is not surprising in view of the condition of the art at that time that two of the three competing electrical companies suggested that a large continuous current motor should be used to drive each room, following in this respect the plan adopted by the best mechanical system then in use. The original recommendations of the General Electric Company, however, were finally adopted, and the

mill was subdivided into seventeen comparatively small sections, each driven, independently of all the others, by its own motor. Each department was kept distinct from all others. In order to save floor space, the motors were suspended from the ceiling, and in most cases each was provided with two pulleys on each end to equalize the strain on the shaft and to reduce to a minimum the friction and wear on the bearings. It is interesting in passing to note that the type of motor selected, as well as the plan in all its important details as recommended by the General Electric Company, are those which have been adopted in practically all textile mills using what is known as the "group system" of electric driving.

The success attending the introduction of the electric drive at the Columbia Mills resulted in its adoption by many other mills in that section, where water power was available. In some other parts of the country the electric system was used as additional power to supplement insufficient mechanical systems. The advantages obtained by the subdivision of the mill into small sections in the Columbia Mills installation became so apparent that, in 1896, a careful study was made of the possibilities of applying the motors directly to the textile machinery. On March 1, 1897, a contract was closed by the General Electric Company with the Anderson Cotton Mills, of Anderson, S. C., for forty-two six horse-power motors. Each of these motors was so located as to drive a spinning frame from each end of the motor shaft through a friction clutch. This installation proved so successful that two repeat orders were placed for similar equipments. Although a marked increase of production resulted from this application, it was not generally adopted, however, for several reasons. The motors at that time were so expensive as to preclude the advisability of driving each frame by its own motor, and the plan of driving two frames by one motor was very limited in its application, inasmuch as it was impracticable, unless the motor and frames could be located upon an absolutely solid foundation. At the Anderson Mills the frames and motor were located upon a concrete floor. Inasmuch as the spinning frame would usually be located on the top floor of a mill, this condition could not be duplicated in the ordinary mill with its wooden floors. Both of these difficulties have since been overcome. The principal objection, however, still remained that this method of connecting the motors directly to the frames did not permit any changes in the speed of the frame cylinder. Accordingly, experiments were made, in 1901, at the Pierce Mills, in New Bedford, with a view of driving the frame by a pinion on the motor shaft, which meshed into a gear on the cylinder shaft. By reason, however, of the inertia of the rotating member of the motor as then designed, with its large diameter and comparatively heavy weight, too long a period elapsed between the time when the current was shut off and the frame was stopped, thus permitting the yarn to kink and break. Later improvements in the design and reduction in the first cost of electric motors have rendered this form of gear driving feasible,

and it is now being adopted in many cases, modified in some instances by the substitution of chains and sprockets for the gears. Since these installations were made at the Anderson Mills and Pierce Mills, modifications and changes have been made in the design of alternating current motors, and it is quite probable that in the near future the desired variations in speed may be secured with an alternating current motor directly attached to the cylinder shaft. It is quite probable also that some mechanical means may be devised whereby, with the motor running at uniform speed, this desirable result may be obtained.

Previous to the year 1897 the electric generators supplying current to the motors in textile mills had either been driven by water wheels or had been operated from steam engines by means of belts or ropes. The electric system had not sufficiently demonstrated its advantages to lead mill engineers to consider the installation of a large reciprocating engine with a generator directly connected thereto. It is interesting to note in this connection that Mr. Stephen Greene, to whose foresight and courage the first installation owed its adoption, was also the engineer in charge in this second step in the application of the electric system in the driving of textile mills. On November 24, 1897, a contract was closed by the Lancaster Mills, of Clinton, Mass., with the General Electric Company for a 1,250-kilowatt, 3-phase, 40-cycle, 600-volt generator, directly connected to a cross-compound Cooper-Corliss engine. The engine had a speed of seventy-five revolutions per minute. This engine and generator were used to drive about one-half of the mill, the balance still being operated by the mechanical system. So successful were the results obtained by this installation that on May 10, 1899, a second contract was closed, also with the General Electric Company, covering a 1,650-kilowatt, 40-cycle generator, together with a Cooper-Corliss engine designed for a speed of seventy and one-half revolutions per minute. With the addition of this second generator the entire premises were driven electrically. In view of the criticisms which have been made on account of the periodicity (forty cycles) adopted in this and later plants, it is proper to state that it was adopted in order to facilitate the operation of the generators in parallel. The prevailing periodicity at that time was sixty cycles, but up to that time no generators of the slow speed called for by the above contract had been operated in parallel on sixty cycles. On account of this slow speed it was considered necessary to adopt a much lower frequency, and forty cycles was chosen, and for several years continued to be the standard for such work.

Previous to 1899 the applications of the electric drive in textile mills, in which steam engines furnished the motive power, had been confined entirely to the replacement of the mechanical system. The Olympia Mills, of Columbia, S. C., was the first new mill, so far as we have any record, in which it was contemplated at the outset to distribute the power electrically where steam engines were to be used to drive the generators. W. B. Smith,

Whaley & Company, of Columbia, S. C., were the engineers for this mill. A contract was closed September 13, 1899, with the General Electric Company covering three 1,300-kilowatt, 40-cycle, 600-volt generators, each arranged for direct connection to a McIntosh & Seymour vertical cross-compound engine, running at a speed of 133 revolutions per minute.

It was in the silk industry that the first application of individual motors to looms was made in this country. For several years this method of driving had been common in Germany, France and Switzerland, but the comparatively high first cost of the motors had precluded its adoption in this country in spite of its advantages. In March, 1901, however, the Royal Weaving Company, of Pawtucket, R. I., imported 170 looms, to each of which was attached a one-third horse-power Oerlikon motor. A reduction in the cost of induction motors has since rendered this system very attractive, and there are to-day many thousand silk, woolen and worsted looms driven in this manner.

The Saxony Worsted Mills, of Newton, Mass., was the first textile manufacturing company to venture upon the driving of each mule by its own motor. On December 5, 1906, a contract was closed with the General Electric Company for sixteen motors for this purpose, and six months later the balance of the mules in that mill were thus equipped. Up to that time only the group system of driving had been used in the operation of mules on account of the variable nature of the load and the special characteristics which would be required by the motors. This problem was successfully solved, however, in this mill, and for smoothness of operation and ease of control it cannot be duplicated by the mechanical system.

RESULTING EFFECTS.

With the adoption of the electric system it has become necessary to obtain more accurate information in regard to the distribution of power in the several departments of a mill. Before the advent of this system the mill engineers had determined the total amount of power required to operate an entire mill under given conditions, but the results of an error in distribution of that power were not so serious, as an underestimate in one department would be balanced in all probability by an overestimate in another department. With the subdivided system of driving, more accurate information was required, and, as the extent of that subdivision increased and the motors operating under the group system were reduced in size until finally the individual drive was reached, it became very necessary to know the power required by each of the several machines under the many diverse conditions under which it would be called upon to operate. Thus the electric system has compelled the manufacturer and the engineer to ascertain more accurately and more in detail than was previously the case the distribution of power about his mill, and

a means has been provided whereby unnecessary consumption of power can be avoided. Wherever the electric drive has been adopted, especially where subdivision has been followed, an increased production has resulted. This is due to the omission of steps in the transmission, thus reducing the opportunities for loss of speed, the speed being maintained nearer to the theoretical maximum. This more regular and constant speed has also resulted in corresponding improvement in the quality. This is most marked where the motor is applied directly to the loom, as the "beat up" is uniform. The fire risk from overheated journals and from rubbing belts has been reduced to the same extent that these items have been eliminated. The manufacturing rooms have been made cleaner and lighter, and the air has been freed from the lint and dirt circulated by the large horizontal belts. This has been of direct benefit to the operators. In large steam-driven mills, using over 1,800 horsepower, the first cost has been reduced below that of the mechanically driven mill in the majority of cases, especially if the looms are located in a separate weave shed. This has been brought about, in part, by the introduction of the steam turbine in place of the reciprocating engine. Mill sites, not otherwise suitable for the purpose, have been made available, as the steampower plant and the manufacturing buildings could be located at a point most suitable for the processes carried on in the several buildings respectively.

Probably the most marked result following the introduction of the electric system, however, has been found in the concentration of power plants. Under the mechanical system each factory, and oftentimes each large building, was compelled to have its own independent prime mover. In many mill yards in which the mechanical system is used there will be found several independently operated steam plants, each complete in itself and each under the control of a high-salaried engineer. Each manufacturing building is operated entirely independently of the others, and in case of an accident in one building the machinery in that building cannot be driven from any of the other power plants. Under such a system, if, for any reason, the original estimate on the power required in one building was exceeded, the manufacturer could not draw from his other power plants to supplement this deficiency, although there might be a surplus in each of the others. The larger the manufacturing establishment, the more marked do these limitations of the mechanical system become. With the advent of the electric system this was entirely changed, and large power plants are now being erected at the most advantageous point, and all the power required about the entire premises is being generated in one central station. Not only does this result in economy in the cost of fuel and labor and a reduction in first cost of the power plant itself, but it permits the employment of a higher grade chief engineer and insures the operation of the plant at its highest efficiency. In case of an accident within the power-house, selection may be made by the manufacturer of those portions of

his establishment which it is most desirable for him to operate. This plan of the concentration of power plants is being followed in many of the larger mills throughout the country.

The advent of the electric system has opened up an entirely new field of operation for the engineer and the manufacturer. This has already been referred to briefly in regard to the utilization of hitherto inaccessible water powers. Probably no other section of the country has profited as much by the introduction of the electric system as have North Carolina, South Carolina and Georgia. In these states many millions of dollars have been invested in the development of water powers which would otherwise have remained unused. On account of the cheapness of the power thus developed, many textile mills have been built which could not have been operated at a profit under previous conditions. The current from these central stations has been distributed over very wide areas to these mills, which have been located at the distribution centres, and the amount of money invested indirectly in the building of towns and other enterprises exceeds many times the investment in the electrical apparatus itself. New villages have been built and employment has been given to many thousands of operatives who otherwise would have remained on the farm or in other less remunerative occupations. Thus, most important, economical, sociological and education results, not contemplated by its early advocates, have followed the introduction of this electric system.

MILL ENGINEERING

BY F. W. DEAN

Scope of the Work.—The work of the mill engineer and architect consists in determining the general arrangement of a plant for the accommodation of the machinery necessary to produce a given quantity of goods of a given kind, the determination of the kind and the amount of the power, the determination and arrangement of the machinery of transmission and the design of the buildings. The contour of the land, the surroundings of the site, the location of the means of transportation, and other things modify the design. The work of the designer is more of an engineering character than otherwise, and architecture takes a secondary position. The mill engineer should be a man well trained in the fundamental principles of engineering, for with this equipment he can undertake problems and carry them out with wise discrimination. He should know many things about boilers, engines, machinery of transmission and building construction. He will often be called upon to undertake the construction of a mill for the manufacture of articles that he has never seen or scarcely heard of, or, in textile mills, for the production of a fabric entirely new to him; having a sound engineering education, reinforced with sufficient experience to produce sound judgment, he will be well qualified to carry out such projects.

Regular Mill Construction.—Regular mill construction originated in New England and is carried out to the greatest perfection in that part of the country, chiefly in textile mills. As now designed by the best mill engineers, it consists of brick walls, heavy transverse wood floor beams, covered with thick, splined plank, spiked on at right angles to the beams, the latter being covered with top flooring nailed at right angles to the plank. The spaces between the centres of the beams, or bays, should not be so wide as to require beams at right angles to the main beams, or any subdivision of the bays. Mill construction contemplates the smallest practicable number of heavy beams with heavy planks, the simplest forms, the least surface for contact with fire, and concealed metal where used. It also contemplates columns from bottom to top, resting on cast iron pintles through the beams, so that there will be no lengthwise shrinkage of the column system. By this construction the shrinkage of the floor beams and planks affects each floor independently, and is not cumulative.

The floor beams tie the sides of the building together, and when the

beams are placed and fastened to each other and to the walls, there should be no transverse strain on the brickwork until there is a disturbing effort, such as wind pressure and vibration from machinery. On account of the great compressive strength of cast iron, pintles are small in diameter, even when hollow, and therefore cut away the beams but little. They thus give room for a wrought iron dog on each side with ends bent over not quite at right angles, so that when driven into holes in the beams they draw them firmly together. The beams should not be fastened to the walls until after the dogs are driven, so that they will slide in the walls as the dogs draw them together. This requires the use of a wall plate or wall box, which has no projections to enter slots or holes in the undersides of the beams, for such a method cannot be carried out in practice without preventing the consummation of the desirable features of construction described above. The only way to fasten the beams to the wall plates or boxes to conform to the best principles of mill construction is to use lag screws passing through the plates, which project out of the walls sufficiently far for this purpose. The plates or boxes have ribs that can be built into the walls and thus tied to the brickwork. After the beams are fully placed the column caps are secured to the beams by lag screws, thus firmly securing the columns and tying the beams together on the underside.

Beams usually end over columns so that a half hole is cut through their ends for the pintles, but if a beam does not end over a column a hole is bored for the pintle and dogs are not required. No attempt should be made to have the pintle fit the hole, as it should be free to maintain its position when moving the beam and driving the dogs. When cast iron columns are used, pintles are usually dispensed with, the columns passing through the beams to the level of the floor and there formed to receive the columns of the next story.

While there is no objection to carrying an iron column through a floor at the top of the column, there is a serious objection to carrying it, or a wood column, through a floor at the bottom of the column. In the latter case, when a floor above falls, it is likely to push columns over, and if they pass through the floor below the beams will be pried endwise. This may be sufficient to cause them to drop off the columns, thus causing another floor to fall, and in fact all floors below would probably fall. The prying of the beams pushes the walls out and thus the absence of the most advanced features of mill construction might cause the wreck of a whole building if the top floor should be destroyed by fire.

Another advantage of the use of pintles is that on account of their small diameter the beams rest over the body of the columns and are not held to any great extent by the column caps. Even if the ends of the latter should break off, the beams would stay in position. This is an argument in favor of using caps and pintles for iron columns, for when such columns

pass through beams they cause the weight of the floor to be carried by brackets cast on their sides, thus putting the brackets in transverse strain, which is not desirable.

Cast iron columns with separate bases and caps simplify foundry operations to a desirable extent, especially as mill castings are likely to be made at second-rate foundries.

Dogs should always be put in on the tops of beams and depressed in grooves, so that the floor planks can be laid without difficulty. The plank prevents their coming out, and they are concealed.

Floor beams, when doubled, should have no space between them, as was formerly the practice, to permit air to circulate between, for the purpose of preventing dry rot, as these spaces hold fire tenaciously.

Floor planks are usually two and one-half inches to five inches thick, and occasionally six inches thick, and in widths not exceeding ten inches. They should be at least two bays long, except enough one-bay lengths to cause breaking of lengths. It is not necessary to have every other plank break joints. Four or five planks of the same length can be laid side by side, and the next set can break joints with these.

In cases where there are twice as many bays as there are rows of columns, the intermediate beams rest on longitudinal stringers. Vertical shrinkage is considerable in this construction, and pintle tops may appear so far above the top floor as to show a cavity underneath, unless they are suitably designed.

Columns should not be bored, because nobody is able to identify benefit from this practice.

Nails should enter beams about three inches, and should be two in number at each bearing. Top floors should be of square-edged maple, in lengths of not less than six feet or eight feet. They are usually about five inches wide, and usually seven-eighths inch thick. They should be nailed with two nails two and one-half inches long, on diagonal lines sixteen inches apart, along each board, with two nails at each end. Nails should be set and boards should be planed after nailing.

Roofs are framed, supported and planked similar to floors, using dogs, and they should be driven before the brickwork is built around the anchors. When there is not a row of columns in the centre of the room, the roof beams should not be carried on the slant to the centre of the mill and there fastened together with the expectation that a stable roof will result. Horizontal beams should run between the two rows of columns next to the centre, and the roof slant should be obtained by wedge-shaped pieces nailed to the beams. Roof beams are not secured to the walls by means of plates or beam boxes, but plates could be advantageously used.

It is best to have inside drainage for mill roofs, and this can be best accomplished by upturned edges. Conductors can be of galvanized iron

or cast iron pipes, the latter being preferable. Thimbles should be of copper and goose necks of lead, not fastened into the conductors.

Roofs for textile mills should be covered with six-ply tar and gravel roofing. While there are many cheaper roofings that are guaranteed for ten years, the thickness of six-ply tar and gravel roofing is advantageous on account of its heat non-conducting properties. Cold roofs cause condensation under certain circumstances. Weave shed roofs require further insulation.

Fire Protection.—The simplicity and lack of interruption of the spaces between the beams, of mill construction, augment the range and add to the effectiveness of automatic sprinklers. The water in a sprinkler system should flow promptly with great force, and come in plentiful quantity. If a city supply for any reason cannot fulfil these requirements, there should be an elevated tank and a fire pump. The tank should contain water enough to be effective while the fire pump is being started, and the pump should be sufficiently protected to be the last thing to be disabled. The source of supply of the pump, if a pond or river is not available, should be a reservoir, the capacity of which is specified by the insurance company.

Steel Floor Beams.—Steel floor beams are used somewhat, but they do not fulfil the requirements of regular mill construction, because they soften when heated and the floors therefore fall in case of fire. They have the advantages of rendering narrow piers and great width of windows practicable for a given width of bay, and permitting columns to be farther apart than with wood beams. This facilitates the arrangement of machinery by diminishing the number of columns.

For securing the planks, nailing strips four inches thick, and as wide as the flange, are fastened to the beams by means of lag screws, through the upper flanges, at intervals of about thirty-six inches on each side, the holes alternating. To these the planks are nailed as usual. Planks are also secured directly to the flanges or steel beams by driving small railroad spikes from below by means of pneumatic hammers.

Reinforced Concrete.—Reinforced concrete is a comparatively recent material for use in mill construction. It has the advantages of resisting fire better, probably, than any other material, and of being rigid. It is customary to say that it costs from ten to fifteen per cent more than regular mill construction, but it is more likely to be twenty-five per cent. It is not only more costly than regular mill construction, but there are secondary additional costs due to special devices for securing hangers, pipings, wires, etc. These should all be worked out in advance so as to avoid cutting the concrete. Concrete floors often must be covered with wood because of the prejudice against concrete. This prejudice doubtless comes from the cooling effect of concrete on the feet.

All things considered, including the present price of lumber and bricks, reinforced concrete may be said to be somewhat premature for mill con-

struction. Means of reducing the cost of forms are being studied by making them of metal and in such a way that they can be used repeatedly.

One objection to reinforced concrete, as usually constructed, is the depth of the beams, and this has been overcome by the so-called mushroom or similar construction.

While concrete buildings have failed, this appears to have occurred during construction.

Shafting.—Little can be said concerning shafting, which, for many years, has been very perfectly developed. Ball and socket bearings and ring oiling have made it as perfect as practicable without ball or roller bearings. Since automobiles have shown how perfect such bearings are, it is time that they were given more serious consideration in mills. The friction of textile mills ranges from about eighteen per cent to forty-five per cent, thirty per cent being common, and it can be reduced, probably, to twelve per cent by ball or roller bearings. The larger frictions are caused by want of alignment, which should be more frequently attended to.

Use of Electricity.—In the case of a simple arrangement of buildings where direct belt or rope drives can be used, there is nothing as good as an economical piston engine using belts with power up to about 1,000 horsepower and ropes for powers above. Electricity is to be preferred where mills are at odd angles with each other, where they are scattered, as is usually the case in old plants and where a central station can be used. The latter reduces the cost of attendance, diminishes waste room and contributes to convenience in several ways.

Alternating current is to be preferred to direct in textile mills. In such mills the power factor is high and the disadvantage of a low power factor disappears.

Group driving is in general to be preferred in textile mills. In the cases of machines that run intermittently, individual motors are to be preferred. For elevators the motors should not be constant-running, because they reduce the power factor.

Piston Engines and Turbines.—When electricity is used steam turbines are to be preferred to piston engines. They are now fully as economical in the smaller, more so in the larger sizes, take up less room, require less foundations, use less oil and general supplies, and are more reliable. They use no oil in the steam and thus render condensed steam harmless for boilers, which, in bad water districts, is of the greatest importance.

Boilers.—Economy, durability, low cost and freedom from danger can be said to be the desirable features of boilers. The horizontal return tubular boiler combines these features to a greater extent than any other kind. The economy is permanent because the tubes can be both blown and scraped and thus made as clean at any time on the fire sides as when new. On the water sides scale can be cracked off by the use of a multiple hammer passing through the tubes. Compared with water tube boilers, another cause

of economy of the fire tube boiler is the smaller area of brickwork and the almost entire absence of cleanout doors, both of which reduce air leakage. Water tube boilers become dirty and can never be made clean, except by radical and expensive means. Many of the tubes become incrusted with clinker, and in some the tubes have tiles on one side and clinker on the other, and in either case the heating surface is all but useless. Horizontal return tubular boilers do not short circuit the gases because the distance from any point in a transverse line on the grate to the uptake is the same through corresponding tubes, and the resistance to passage of gas is the same. In water tube boilers there is much short circuiting and corresponding uselessness of some of the heating surface.

For safety the horizontal return tubular boiler has a unique history, for there has not been a single explosion of such a boiler when built with butt longitudinal joints. These joints can be improved, which will render explosions even less probable.

For size, 90-inch horizontal return tubular boilers of 400 rated horsepower have been built, and they are perfectly successful. They have been continuously worked to nearly double their rating with great economy. The size can be increased to 500 horse power without disadvantage, and there is no ordinary limit to the pressure that can be carried. The theory of the transmission of heat shows that the resistance to its flow through steel plates is only slightly increased by increasing their thickness, and there should be no hesitation in making them one inch or more thick. A ninety-eight-inch boiler for 200 pounds pressure, with 5,000 square feet of heating surface, is feasible and unobjectionable. Dirt on the water sides is the only cause of trouble, and this is equally troublesome on thin plates.

For forcing, the horizontal return tubular boiler is unequalled, except by other fire tube types, and no boiler will respond to sudden demands better. While it makes no difference to forcing capacity, it is a matter of interest that this type of boiler contains less water, in proportion to heating surface, than any other.

The vertical fire tube boiler is more economical than the horizontal tubular when fired properly, but it requires more skill in firing. It is more economical because its heating surfaces keep cleaner, all parts of the tubes are equally effective, and because there are no opportunities for air to leak in and cool the gases. With an economizer the latter is more effective than with boilers in brickwork, because the gases leave hotter, due, not to the inability of vertical tubes to absorb heat, but to the gases escaping at their normal temperature, as noted above. As usually built, these boilers have leaky smoke boxes and covers, which neutralize this, and this practice should be discontinued. For economy of space vertical boilers about double the horsepower on a given floor area, compared with horizontal. An important feature of these boilers is that they superheat the steam from twenty degrees to forty degrees, thus causing economy of steam in engines.

HISTORY OF FACTORY FIRE INSURANCE

BY FREDERICK A. DOWNS

The first fire insurance company established in America was organized in Pennsylvania, April 13, 1752, at the instigation of Benjamin Franklin, James Hamilton, then Lieutenant Governor of the Province, being the first subscriber to its articles of agreement.

The title of this company was the "Philadelphia Contributionship For The Insurance Of Houses From Loss By Fire," commonly called the "Hand In Hand Fire Insurance Company," due to the fact that the company placed a seal on each house that it insured, representing four hands crossed and clasped at the wrist.

No other fire insurance company was organized in America until 1783, but by the close of the century there had been organized in this country ten mutual and four stock fire insurance companies, and by 1820 this number had increased to seventeen stock companies in New York, six in Pennsylvania, two in Connecticut, and one each in Rhode Island, New Jersey and Massachusetts.

In all of these companies the underwriting of cotton mills was looked upon with distrust and fear, and many of them refused absolutely to insure this class of business at any price.

The rates in such companies as would insure cotton mills for limited amounts were the highest paid for any class of property existing at that time.

While the rates charged on cotton mills were published at from one and three-quarter per cent to three per cent, a woolen mill was considered less hazardous to the extent that the insurance companies were willing to insure this class of property at from one per cent to one and one-quarter per cent.

From a pamphlet on "Fire Hazards," published by Captain Wm. Jones, Secretary of the North American Insurance Company, in 1823, is extracted the following as applied to the insuring of cotton mills from the underwriters' point of view:

"COTTON MANUFACTORIES: The exemption of these establishments from conflagration depends less upon even the best mechanical safeguards in the construction and arrangement than upon a well-organized system of management, combining vigilance, cleanliness, order, and discipline; without these, the highest possible premium would be inadequate to

the risk; gunpowder itself is not so inflammable as the atmosphere of a cotton mill, where the waste and dust of the staple are suffered to accumulate from time to time among numerous lamps or candles, which may be presumed to be managed with equal negligence."

The feeling of the underwriters in relation to the insuring of cotton mills was particularly emphasized by an incident which occurred in Boston, Mass., in 1850. The owner of what was at that time considered a large cotton mill called on the president of one of the prosperous fire insurance companies in that city and asked if he insured cotton mills, to which he replied: "Oh, yes, we insure them to burn up at a very low rate, but we do not insure them against loss by fire at any rate."

Previous to 1835, notwithstanding that high rates and unusual and exacting policy conditions were imposed upon the cotton manufacturers, no steps had been taken to overcome the existing difficulties and provide a means for the protection of their properties with suitable insurance at reasonable cost. During the year 1835 Mr. Zachariah Allen, owner of the Allendale Mill, at Allendale, R. I., together with a number of business associates and fellow-manufacturers, organized the Providence Manufacturers' Mutual Fire Insurance Company, of Providence, R. I. (this title afterwards being changed to the Manufacturers' Mutual Fire Insurance Company of Providence, R. I.) In 1848 the Rhode Island Mutual Fire Insurance Company of Providence, R. I., was established. The object of these companies was the insuring of manufacturing and warehouse properties, and this object was maintained except in a few isolated cases when houses and barns were accepted. Th incorporators of these companies consisted largely of woolen and cotton manufacturers, Mr. Allen then being engaged in the manufacture of woolen goods at his Allendale mill. The records of the companies show, however, that the largest proportion of the risks insured were cotton mills.

The largest amount assumed by each company on a single risk was $15,000, the balance being placed in such companies as could be induced to accept it. The basis on which rates were made by these companies was the accepting by them of about three-quarters of the rates charged by the stock insurance companies on the same property, this being necessary on account of the lack of suitable statistics and experience in the insuring of manufacturing property exclusively. The policies or contracts of indemnity were made on the simplest form possible, it being agreed among the incorporators that by the careful selection of their assured and the acceptance by them of only desirable members, each member would keep faith with his associates, and there is no record of there having been any attempt on the part of any member insured to take advantage of the other members, which gives evidence of the high moral hazard of the parties insured. Among the several objects for the establishment of these companies was the avoidance of clauses and restrictions in their policies that invariably complicated a

proper and equitable settlement of loss and with which almost all insurance contracts were at that time encumbered.

The care exercised by the management in the selection of their business and the rigid economy practised by them gave evidence early in their history of the success of the undertaking, and which led to the organization of the Boston Manufacturers' Mutual Fire Insurance Company in Boston, Mass., in 1850, by Mr. James Reed, of that city, and Mr. John L. Hughes, of Providence, R. I., Mr. Reed occupying the position of Secretary until he resigned on account of ill health, when Mr. Edward E. Manton, of the Rhode Island Mutual Fire Insurance Company, of Providence, R. I., became the chief executive officer of the Boston company, retaining the executive control of the Rhode Island Mutual Fire Insurance Company and acting in the capacity of chief adviser of the Manufacturers' Mutual Fire Insurance Company, of Providence, R. I.

With the organization of the Boston Manufacturers' Mutual Fire Insurance Company the underwriting under the original method was increased to $60,000 on a single risk, by the acceptance by the Boston Company of a maximum line ot $30,000. Following the organization of this company other companies were organized in the following order:

Firemen's Mutual Insurance Co.,	Providence, R. I.,	1854
Worcester Mfrs. Mutual Insurance Co.,	Worcester, Mass.,	1855
State Mutual Fire Insurance Co.,	Providence, R. I.,	1858
Arkwright Mutual Fire Insurance Co.,	Boston, Mass.,	1860
Blackstone Mutual Fire Insurance Co.,	Providence, R. I.,	1868
Fall River Mfrs. Mutual Insurance Co.,	Fall River, Mass.,	1870
Mechanics' Mutual Fire Insurance Co.,	Providence, R. I.,	1871
What Cheer Mutual Fire Insurance Co.,	Providence, R. I.,	1873
Enterprise Mutual Fire Insurance Co.,	Providence, R. I.,	1874
Merchants' Mutual Fire Insurance Co.,	Providence, R. I.,	1874
Hope Mutual Fire Insurance Co.,	Providence, R. I.,	1875
Cotton & Woolen Mfrs. Mutual Insurance Co.,	Boston, Mass.,	1875
American Mutual Fire Insurance Co.,	Providence, R. I.,	1877
Phila. Mfrs. Mutual Fire Insurance Co.,	Philadelphia, Pa.,	1880
Keystone Mutual Fire Insurance Co.,.	Philadelphia, Pa.,	1884
Rubber Mfrs. Mutual Insurance Co.,	Boston, Mass.,	1886
Paper Mill Mutual Insurance Co.,	Boston, Mass.,	1887

After 1887 other companies were organized in several of the other states until, in 1911, there are thirty-two (32) companies operating under the same uniform methods and in co-operation with each other.

From the organization of the parent company in 1835, until 1878, the sole purpose of the management seems to have been to select their risks with care and to practise the most rigid economy, saving for their policy-

holders as much money as possible in the cost of their insurance, distributing to them upon the expiration of their policies such saving over the losses and expenses as they were able to effect during the period.

Each company acted independently of the other companies, although there was a community of interest in the fact that they were underwriting on the same property. Inspections were made about once a year by the executive officers, usually just prior to the expiration of their policies; other than this, their methods differed in no essential respect from the other fire insurance companies existing at that time.

In 1878 it was found that the magnitude of the business was such as to make it impossible for the officers to inspect their risks as often as was considered necessary, and the expense of maintaining an inspection staff of competent men for each company was too great to be considered favorably; it therefore became manifest that some other and more economic method must be adopted, as the risks required, if anything, more care and attention than formerly, due to the rapidly growing business and the increasing hazards, brought about by new methods and labor-saving devices. It was finally decided that by the establishment of an Inspection Department for the joint benefit of all of the companies it could be conducted economically and at a cost well within the means of the several companies. An Inspection Department was, therefore, established in Boston, Mass., under the direction and supervision of Mr. Wm. B. Whiting, Secretary of the Boston Mfrs. Mutual Fire Insurance Co., a man of exceptional ability and extraordinary memory, and through the efforts of this gentleman, coupled with those of Mr. Edward E. Manton and Mr. Edward Atkinson, this department was a success, both financially and in the assistance it rendered the manufacturers in the care of their properties. Quarterly inspections were made of each risk insured; modern safeguards were investigated and applied, and in 1880 the automatic sprinkler was adopted and every device that would reduce the fire waste of manufacturing property was applied to the risks insured by these several companies.

With the establishment of the Inspection Department the companies were brought into closer association, and, before the close of the year, a conference of the chief executive officers of the several companies was established and meetings were held monthly, at which meetings all subjects were discussed and proper action taken pertaining to the improvement in manufacturing properties, application of proper forms, uniformity of rates and other conditions looking to the reduction in the cost of insurance to the manufacturers. This conference or association was known as the Factory Mutual Fire Insurance Companies, but, as this class of companies was originally established in New England, they were very commonly known as the New England Factory Mutual Fire Insurance Companies.

Thus was established in the history of fire insurance the single instance of a system of insurance for the exclusive insuring of manufacturing

and warehouse properties, coupling the prevention of loss by fire as the prime motive with the payment of indemnity in case of unavoidable losses as an incident.

In the operation of these companies no commissions were paid to agents and brokers for the securing of the business, but the companies dealt direct with the principals; no property was insured until after it was inspected and brought up to a uniform standard of construction and protection, and by the care exercised in their management the savings to the insured have increased each year from an initial saving in the early history of the companies of about twenty per cent of the premium charged, to an average of about ninety per cent in 1911.

In dealing more particularly with insurance on cotton manufactories, it is to be noted that since 1835 they have been gradually brought up to a high standard of perfection, and through the efforts of the owners of the properties, with the assistance of the officers and inspectors of the Associated Factory Mutual Fire Insurance Companies, their loss ratio in a series of years is less than that of the woolen manufactories, and from a rate of one and three-quarters per cent to three per cent in 1835, the cost has been reduced to about ten cents, which gives evidence that under proper management and the adoption of proper safeguards a hazardous risk may be made uniformly profitable to the insurance companies; thus, in the organization of these companies the cotton and woolen manufacturers were instrumental in establishing a system of insurance that has been of inestimable value to the manufacturers in general during the entire period.

COTTON SEED AND ITS PRODUCTS.

BY E. M. NORRIS

The varied uses to which the seed of the cotton plant may be put, and the commercial value of the products obtained from it, entitle it to consideration in a volume which treats of the manufacture of cotton. Though the cotton plant has been cultivated from time immemorial for its fibre, it was not until a comparatively modern date that the oil-producing properties of its seed, the valuable qualities of its oil, and the important and varied uses to which it could be put, were even imagined. The Chinese, it is true, crushed the seed of their native cotton and consumed the oil expressed from it in their primitive hand lamps, and also recognized the fertilizing qualities of the crushed residuum probably centuries before the discovery of America. But their knowledge was not disseminated, and civilization owes little to it. The eighteenth century was nearing its close when the attention of modern men was directed to the fact that cotton seed contained a useful oil. It is stated that in the year 1783, when the cotton industry was still in its infancy in England, a cask of cotton-seed was brought there from the West Indies and presented to the Society of Arts, an organization which has for its object the promotion and encouragement of arts, manufactures and commerce, that under its auspices, experiments might be made as to the possibility of extracting oil from the seed. This intention was carried out at the mill in the city of London in the presence of the Secretary of the Society, and the oil so obtained was used in experimental efforts to determine the uses to which the oil might be applied, a sample of it being preserved by the Society. In consequence of these experiments, the Society offered gold and silver medals: the first to be bestowed upon "the planter in any part of the British islands of the West Indies, who shall express oil from the seed of cotton, and make from the remaining seed, hard and dry cakes, as food for cattle," a part of the condition being that one ton of oil should be expressed and five hundredweight of the cake obtained; the silver medal was destined for the person manufacturing the next largest quantity of oil and cakes, but though the offer was made in later volumes of the Transactions of the Society, there is no record of its ever being called upon to award the medals.

Nevertheless, a number of mills in England and France became engaged in the business of expressing oil from cotton seed, imported from India and Egypt, and so brisk a demand arose for the oil, which was

applied to industrial purposes, and for the crushed kernels for stock-feeding purposes, that the mill owners made several attempts to import American seed to supplement the supply from other sources.

The Upland seed being unsuited to their purpose, they turned their attention to the smooth hulled Sea Island seed, and for some years a thriving business was done in the exportation of Sea Island seed to Europe from Savannah and Charleston. The rapid advance made in the process of preparing cotton seed oil by both British and French, is shown by the fact that in the Exposition of 1851, Mr. Burns, of Edinburgh, and M. de Gemni, of Marseilles, were awarded prizes for samples of that commodity, and the real history of the industry may be said to date from that period.

For more than seventy years after cotton had become the most important crop in the Southern States, the seed was a wasted product, and as the seed is, by weight, two-thirds of the cotton crop, the disposition of this enormous amount of refuse was a matter of grave moment to the planter and the ginner. The accumulations of seed about the gins were hauled to some remote spot, there to decay, or dumped into some running stream, to contaminate and infect the water, which, as the population increased about these centres of industry, became a menace to the public health. Therefore, laws were passed in Mississippi, in 1857, forbidding such disposal of the seed under penalty (See Revised Code of Mississippi, 1857, page 207). Other States followed this example, and tons of seed were burnt and the ashes used as a fertilizer, and thousands of tons were piled high on worthless land and surrounded by strong fences, for common tradition held it poisonous to cattle. A few adventurous planters had made use of small rude mills and presses, and used the oil so obtained for plantation purposes. Shingle roofs painted with cotton seed oil were common throughout the South, remarkable preservative qualities being claimed for it. Robert Mills, in his "Statistics of South Carolina," published in 1826, writes: "Mr. Benjamin Waring was one of the earliest settlers of the town of Columbia. He established the first paper, oil, and grist mills here, and expressed from cotton seed a very good oil." In another part of his book, the historian says: "The quantity of oil that cotton seed will yield has been estimated at one gallon to one hundred pounds of seed, which is a very low estimate." From this, the inference may be drawn that the knowledge of the expression of oil from cotton seed was common prior to 1826, in South Carolina. But the difficulty that had confronted the planter as to the ginning of the lint-covered seeds of Upland cotton, before the invention of Whitney's gin, met also the manufacturer of oil from cotton seed, as the absorbent qualities of the seed husks made it impossible to extract more than a small part of the oil.

The following excerpt, from the Niles Register of 1829, is the earliest record of the practical beginnings of the cotton-seed oil industry in the United States, and shows how the difficulty stated above was met. "Cotton-

seed yields a considerable portion of excellent oil. The difficulty of expressing it, in consequence of the quantity and absorbing quality of the integuments of the kernel, has been so great that heretofore no great quantity of the oil has been made. We are happy to announce that a highly respected gentleman of Petersburg, Va., has invented a machine by which the seed is completely hulled and prepared for the easy expression of its oil. The importance of this invention to the Southern country may be appreciated from the fact that the inventor is erecting a cotton gin, and will be shortly prepared to gin cotton for the seed only. This invention, as we understand it, consists of a granite cylinder, revolving within convex pieces of the same substance faced and placed in a peculiar manner. A hopper over the stone supplies the seed; a wire sieve under it separates the hull from the kernel. Dropping through a current of air from a wind fan, it is delivered clean and ready for the press. This machine will probably rank in the country second only to Whitney's gin. About twenty-five years ago, Dr. George Hunter, chemist and druggist of Philadelphia, having made some experiments on the oil of cotton-seed, thought it worth while to remove to New Orleans, where he carried two steam engines, purchased from Oliver Evans, the one for the purpose of grinding cotton seed. He did not find the place so well suited to his purpose as he expected, and did not set up his manufactory. Afterward, about 1818, Colonel Clark, an ingenious inventor, made some experiments on the oil of cotton-seed for burning in lamps. Oil of cotton-seed is selling at Providence, R. I., at eighty cents per gallon."

A small mill is said to have been established on an island off the Georgia coast in 1832; and another was built in 1834, but the venture was unsuccessful from a pecuniary standpoint and was soon abandoned. In 1847, the experiment was tried in New Orleans and again in 1852, but these attempts were experimental and led to no definite results. As the manufacture in France had reached the point of refining and preparing the oil for food, Mr. Paul Aldigé, of New Orleans, visited Marseilles, the chief point of manufacture, in 1852, and having acquired much knowledge as to the requisite processes, on his return to New Orleans in 1855, he and others set seriously to work in the business of manufacturing oil from cotton-seed in that city. About the same time the Union Oil Company was established in the North, with mills at Providence, R. I., and in 1860, there were seven mills making cotton-seed oil.

The Civil War now intervened and practically stultified the infant industry for some years in the United States; and mills at Natchez, New Orleans, and Mobile disappeared. The exportation of seed to Europe had ceased, and the industry was not resumed until the reconstruction of the South had proceeded far enough to permit of the harvesting of a normal crop of cotton. In 1867, Colonel W. D. Mann established the Mobile Cotton Mills, the works being the largest then in existence. A refinery,

soap factory and fertilizer factory were run in conjunction with it, the capacity of the plant being three thousand gallons of oil per diem; his first shipment of oil to New York brought him in handsome returns, but it glutted the market and his second shipment sold at less than half the price of the first; seed and freight were both high, and after sinking $170,-000 in machinery and appliances alone, he abandoned the enterprise. General C. P. Alexander established an oil mill at Columbia, S. C., in 1869, but, although he also set up a refinery and attempted to utilize every by-product, he too was obliged to abandon his venture. He did much by means of literature, which he himself prepared and disseminated, to educate the people of the South to a realization of the valuable qualities of oil.

The first mill in Texas was built at High Hill by Mr. Hillje, and equipped with machinery from Germany. This mill was successful and the pioneer's sons are still continuing the business. In 1871, there were twenty-six oil mills in the United States which exported 547,165 gallons of cotton-seed oil. As the entire output of oil was then exported, this amount represents the production of the mills then operating, and statistics show that only four per cent of the seed of the cotton crop that year (3,011,996 bales) was milled, the remainder being used as fertilizer or allowed to rot upon waste land. But the industry was now permanently established as a legitimate business. At the outset, the processes employed were carefully guarded as trade secrets; nevertheless, the establishments increased and knowledge became more general.

In 1880, there were forty-five mills, and 6,997,796 gallons of oil, valued at $3,275,414, were exported. This represented twenty per cent of the seed of the crop of that year. Up to this year, the production of the oil could be definitely determined by the export statistics, but thereafter home consumption formed a new factor in the industry. In 1890, the crop was 7,472,511 bales, and twenty-five per cent of the seed crop was used; in 1900, of a crop of 9,645,974 bales, fifty-three per cent of the seed crop was used in the manufacture of oil products, and 46,902,390 gallons of oil were exported, the home consumption amounting to as much more. Up to 1885, the oil reserved for domestic consumption had been largely employed for the manufacture of soaps; but the brokers and dealers in the North soon found a new outlet for it as an edible commodity, and with this new use, the industry increased by leaps and bounds. According to the twelfth census report, there were in 1900, 357 oil manufactories in the United States, producing 93,325,729 gallons of oil per annum, valued at $21,390,674. The residuum of the seed, after the oil is expressed, is made into cakes and meal for the feeding of cattle, and this portion of the product is valued at $16,030,576. In the manufacture of these two products 6,945 tons of seed were used.

In the report of the quantity of cotton ginned in the United States in

1902-4, it is stated that there were 618 cotton-seed oil mills in the United States. In 1902-4, the number had increased to 704, in 1905 to 715, and in 1908 there were 848 mills in the Southern States engaged in the manufacture of various products useful to man and beast from cotton seed. These mills operate 2,608 presses, 2,752 gin stands, and 3,126 delinters, in addition to fertilizers and ice plants.

Crude Products Per Ton of Cotton-Seed.

Products	Pounds	Value
Oil	282	$8.61
Cake and meal	713	6.48
Hulls	943	1.29
Linters	23	0.71
Waste	39	
Total	2,000	$17.09

The seed goes from the gin immediately into the storehouse of the oil mill; it is then bolled or screened, to remove all sand and other foreign bodies, after which it is passed through the delinter, that the remaining short fibre or lint may be removed. This operation yields about twenty-three pounds per ton of seed of a commodity technically termed "linters," which brings on an average three and one-tenth cents per pound. This material is used for the making of mattresses, felt hats, pillows, and cotton batting. In 1900, the total amount obtained was 57,272,053 pounds, valued at $1,801,231.

The next process is the hulling, the seed being ground and the hulls separated from the meats by a revolving screen, supplemented by other screens which complete the process; the hulls, in the primal stages of the industry, were used to feed the mill furnaces, but are now largely exported as food for cattle, and are also used in the making of paper stock. For feed, the hulls are ground and mixed with cotton-seed meal. The amount of hulls obtained from the seed crushed in 1900 was 1,169,286 tons at an average price of $1.29 per ton.

The meats, having been freed thoroughly from the hulls, are crushed between rollers. This process ruptures the oil cells and largely assists the cooking process which is for the purpose of evaporating the excess of moisture, to heat the oily matter, and to coagulate the albuminous matter of the seed and thereby reduce its solubility in the oil. The cooked meats are then put into a cake former, which has just enough pressure to cause the particles to adhere without causing the oil to exude. The cakes are then wrapped in camel's hair cloths and placed at once in the hydraulic press in compartments or boxes provided for the purpose. The cakes are then subjected to intense hydraulic pressure, the product of this final stage

being crude oil and press cake. This cake is a most valuable by-product of cotton-seed oil, amounting as it does to 725 pounds from each ton of seed. The cake, either in its primal form or else ground into cotton-seed meal, is used largely as a cattle food, or as a fertilizer applied directly to the ground, or is mingled with other ingredients to produce many prepared fertilizers, and Professor J. H. Connell, of Texas, at a meeting of the Cotton-seed Crushers' Association at Atlanta, Ga., in 1909, made a striking presentation of the value of cotton-seed meal as human food. Cotton-seed meal, mingled with flour, is used in making corn and flour muffins, biscuits, pancakes, gingerbread, dark graham bread, as well as cakes of all sorts. Professor Connell exhibited samples of biscuits and cakes which were highly approved by the members of the Association who tasted them. He stated that in the near future, the cotton-seed crushers of the South would be able to announce an actual discovery of 4,500,000 tons of a new product fit for human consumption. For the calendar year of 1907, the exports of cotton-seed cake and meal amounted to 590,000 tons, the average price of the shipments for 1907 being $25.44 per ton of 2,000 pounds.

The crude oil is allowed to stand in settling tanks for a number of hours, and is then ready for the refining process. The oil varies largely in color and quality, which depends greatly upon the quality of the seed and the localities from which it comes. It ranges from a light brown to a deep black. The oil obtained from the first refining process is known to commerce as "summer yellow oil;" this, when filtered with Fuller's earth, yields "summer white oil" from which is obtained "compound lard" and cottolene. "Winter yellow oil" is obtained by chilling "summer yellow oil" and separating the stearin, which latter product is utilized in the making of "butter, and salad oils" and candles. "Miners' oil" is a white oil obtained from "summer yellow" by the use of sulphuric acid, and is used in miners' lamps.

The average yield of crude oil from a ton of cotton-seed is thirty-seven and sixth-tenths gallons, or 282 pounds, but no doubt with the improvements constantly being initiated in the processes of expressing the oil the maximum amount of fifty-one gallons to the ton will be universally obtained.

The phenomenal growth of the cotton-seed industry is largely due to the vast improvements that have been made in the methods of and appliances for refining cotton-seed oil, which render a much greater amount of fine oil available for the various industries in which it is used.

During the early years of the industry, the oil was mostly exported to be used in soap making, but a surplusage of oil in 1879, when the price per gallon dropped to twenty-three and nine-tenths cents, caused the brokers to urge it into other channels; it was found that it could be combined with beef fat as a substitute for lard; that it could be combined with other substances in the manufacture of olemargarine (in 1900, 11,-

818,921 pounds of cotton-seed oil were used in this industry alone) and other artificial butters; with lard and also stearine, it makes "compound" lard; white cottolene is a mixture of oleo-stearine and specially prepared cotton-seed oil. It is largely used in all these forms by bakers and cooks, and is recognized by chemists and physicians as a high-class food product.

Though cotton-seed oil lacks the peculiar flavor of olive oil, it has come into competition with that article. It was long ago conceded by expert olive oil manufacturers abroad that an admixture of one-third cotton-seed oil with two-thirds olive oil could not be detected, and that it was as pure and wholesome as the best olive oil; it is, therefore, largely used as an adulterant in what purports to be pure olive oil. Italy, feeling one of her chief industries menaced, sought by a prohibitory tax to exclude the imports of cotton-seed oil; which measure apparently did not have the deterrent effect intended, for the exports of cotton-seed oil from the United States have grown larger year by year.

Until about eight years ago, the producers of crude oil depended largely on Eastern and Western refiners for their home markets, about half of the oil being exported; but in 1900, a large number of crude oil mills were purchased by Southern refineries, and thereafter ensued an increased output of the finished products and an increased domestic demand for those products.

There is no reason why the South should not monopolize the manufacture of the best refined cotton-seed oil for edible purposes. Since cotton-seed is liable to depreciate if kept too long or not properly kept, it is evident that the Southern refiner who takes the seed direct from the gin and in his crude mill prepares the seed carefully and speedily for the final refining processes, all on the same premises, has a distinct advantage over his foreign rival, who must use seed that has lain long since it was harvested, and been exposed to various climatic influences. Processes are now being sought which, as well as extracting the twenty per cent of oil now left in the cakes, will render the oil more easily refinable, with less loss. By the means under consideration, it is hoped to recover at least ninety-nine per cent of the oil contained in the seed, and the meal is rendered more valuable as cattle food, because of an increase of ammonia. It is felt that the time will come when all the cotton-seed produced in the South, except that required for planting the next crop, will pass into her own mills and refineries, while the South, having at her command a limitless supply of the best fattening food in the world will become a great cattle-raising country.

Cotton-seed oil is used for an infinity of purposes; the miner, delving deep in the bowels of the earth uses it in the lamp that lights his labors, on account of its non-explosive properties; and the stately cathedrals of Europe receive their "dim religious light" from the same source. The

electrician uses it under certain conditions for insulation; it is used as a tempering oil and for lubricating heavy machinery, for mixing putty, and to a slight extent for mixing paint. Owing to the extremely low price of cotton-seed oil as compared with animal fats, it is largely used by manufacturers of soaps and soap powders both here and abroad. The refining process leaves a residuum amounting to ten per cent of the crude oil; this substance is known as soap stock, or "foots," and is utilized for making wool-scouring soaps and cheap grades of laundry soaps; also glycerine, candle stock, olein, still pitch, etc., the list being too large to insert here.

In the early days of the industry, most of the oil was exported to foreign countries; but the domestic use of it has greatly increased during the past decade, so that while in 1899 the quantity of cotton-seed oil exported during the calendar year amounted to fifty-four per cent of the production; the quantity of oil exported during the calendar year 1909 amounted to only twenty-nine per cent of the quantity returned as produced at the 1909 census. Notwithstanding this fact the value of the exports during decade 1889 to 1909 increased fifty-seven per cent.

The rapid advance of the industry is attributed mainly to the development of superior methods in the refining processes; while the home demand has greatly profited by the high price of hog products, a great percentage of cotton-seed oil being used in lard compound.

The States showing the greatest development in the industry, as indicated by the actual increase in number of establishments, are: Georgia, where the number has grown from forty-six in 1899 to 145 in 1909, or 215 per cent; Texas, from 102 to 191, or eighty-seven per cent; and South Carolina, from forty-eight to 102, or 113 per cent. Texas leads in total value of products, with twenty-three per cent of the output of the whole country; Georgia, Mississippi, South Carolina, and Alabama follow in order.

The largest importing countries of American oil, are, in the order of their importance: The Netherlands, Italy, Mexico, United Kingdom, France, and Germany. While Germany and Denmark are the largest consumers of cake and meal for stock feeding purposes.

The total number of establishments in 1909 were 809, an increase of twenty-seven per cent over those of 1899; while the total value of production had risen from $42,412,000 in 1899 to $107,538,000 in 1909.

SAMUEL SLATER.

Samuel Slater, who has not inaptly been styled the father of cotton manufacturing in the United States, was born at Belper, Derbyshire, England, June 9, 1768; he was the fifth son of William and Mary (Fox) Slater. His father, as the descendant of a long line of yeoman ancestry, inherited an estate entitled "Holly House Farm," and while cultivating his own lands followed the business of a timber merchant. He owned other real estate; and that he was a man of substantial means is evidenced by the fact that he bequeathed a comfortable portion to each of his ten children: the eldest son of course inheriting the estate, where his descendants now live.

Samuel Slater received an excellent commercial education, under a noted schoolmaster of those parts named Jackson. He made rapid progress in his studies, and was particularly proficient in mathematics.

At the age of fourteen, his father placed Samuel with his close friend, Mr. Jedediah Strutt, that he might after trial, should the arrangement be agreeable to both parties, be apprenticed to learn the "art of cotton manufacturing." Mr. William Slater died in 1782 before the indentures were made out, and in 1783 Samuel Slater bound himself apprentice for six and a half years to Mr. Jedediah Strutt. This arrangement did not mean that he was bound apprentice to become a weaver or an operative of any particular kind; but it meant that as a son of a man of means and position he was to learn the "art of cotton manufacturing" in all its branches with a view to engaging in that business himself. Mr. Jedediah Strutt was eminently qualified to instruct him. A successful manufacturer himself, he was possessed of much mechanical genius and had invented a machine for the weaving of ribbed stockings He was also the patentee of several inventions of an entirely different character. He was a patron and later in partnership with Richard Arkwright, and suggested several improvements in Arkwright's spinning frame, which were incorporated in it before it was patented. Strutt and Arkwright built mills at Cromford, at Belper and at Milford, and when the partnership was dissolved in 1881, Mr. Strutt retained the Belper and Milford factories, where the subject of this sketch passed his apprenticeship. Samuel was diligent in his application to business and passed much of his spare time among the machinery. After the expiration of three years he was appointed overseer in the mill, being then barely seventeen. He also became an expert machinist in these mills where all that was latest and best in cotton manufacturing machinery was in motion, and where improvements were constantly being made.

Owing to the contention then taking place in regard to patent rights he had an opportunity of gaining a knowledge of those also, and a great insight into the laws concerning them.

His term of indenture having duly expired, he was employed by Mr. Strutt to oversee the construction of some new works and the setting up of the machinery, in addition to his duties as overseer in the mill. The experience he thus gained was of incalculable service to him when, in the new world, he built and equipped his first mill.

During the latter years of his apprenticeship, his active and ambitious mind had dwelt much upon the possibilities of the future for him, and being apprehensive that the cotton business would be overdone in England, his attention was caught by an article in an English newspaper, mentioning the inducements held out by the legislatures of Pennsylvania and other States to encourage the introduction of improved machinery for the manufacture of cotton, and in particular a bounty offered by the Pennsylvania legislature for "a roll for jennies," which convinced him that America must be destitute of much of the machinery with which he had such full acquaintance, and this induced him to try his fortunes in the Western hemisphere.

He hastened home for some clothing, started to London and took his passage, disguised as a farm laborer. He was considerably handicapped at the outset, for he not only did not dare to embark as a machinist, but he was compelled to refrain from carrying with him the smallest drawing or specification concerning machinery, owing to the strict laws regarding its exportation from England. He therefore left his native land without informing anyone of his departure, and in due time he reached New York, where he obtained employment in a cotton factory on Vesey street, operated by the New York Manufacturing Society, then newly organized. He very quickly ascertained that here was no field for his efforts, and hearing of the experiments then being made at Providence, he wrote to Moses Brown, the wealthy retired merchant who had initiated them, the following letter:

New York, December 2, 1789.

Sir: A few days ago I was informed that you wanted a manager of cotton spinning, etc., in which business I flatter myself that I can give the greatest satisfaction, in making machinery, making good yarn, either for stockings or twist, as any that is made in England, as I have had opportunity and an oversight of Sir Richard Arkwright's works, and in Mr. Strutt's mills upwards of eight years. If you are not provided for, should be glad to serve you; though I am in the New York Manufactory, and have been for three weeks since I arrived from England, but we have but one card, two machines, two spinning jennies, which I think are not worth using. My encouragement is pretty good, but should much rather have the care of the perpetual carding and spinning. My *intention* is to erect

a perpetual card and spinning. [Meaning the Arkwright patents.] If you please to drop a line respecting the amount of encouragement you wish to give, by favor of Captain Brown, you will much oblige, sir, your most obedient humble servant, SAMUEL SLATER.

N. B.—Please to direct to me at No. 37 Golden Hill, New York.

To this letter, he received an answer informing him that experiments had been made in water spinning, but with no success; and Mr. Brown invited him to go to Providence, "and have the credit as well as the advantage of perfecting the first water mill in America."

Mr. Slater accepted this invitation and went to Providence, where he assured Mr. Brown he could do all he had promised in his letter. He visited Pawtucket to inspect the machinery there, and pronounced it worthless. It was then proposed that Mr. Slater should erect the series of machines called the Arkwright patents, which he refused to do unless he were provided with a skilled worker in wood, who should be put under bonds not to steal the patterns, or disclose the nature of the works. "Under my proposals," he said, "if I do not make as good yarn as they do in England, I will have nothing for my services, but will throw the whole of what I have attempted over the bridge."

Mr. Slater at once began the construction of new machines on the Arkwright principles, a work attended with immense difficulty, owing to the fact that he was obliged to rély upon his own mechanical knowledge and his memory for the reproduction of the most delicate and intricate machines. There were at the outset many disappointments and setbacks, and the first frame of twenty-four spindles was much longer in course of construction than had been anticipated, owing to the difficulty of obtaining cards and even tools to work with; all of which had to be made by Mr. Slater himself or under his directions. The card clothing was obtained from Phinney Earle of Leicester, who manufactured hand cards, but when applied to the machines it failed to work properly, the teeth of the cards not having the right angle or inclination, Mr. Slater's instructions for remedying this defect having been followed by Mr. Earle, it was overcome and the machine worked effectively.

In order to give a fair understanding of the immense service rendered to the cotton industry of the United States by Mr. Slater in accomplishing this work, it is necessary that we should describe the status of the manufacture at that time, and the experiments that had been made to better it.

About 1788, Daniel Anthony, Andrew Dexter and Lewis Peck, of Providence, had formed a partnership to make what was then called homespun cloth. The idea at first was to spin by hand and manufacture jeans with linen warp and cotton filling, but learning that Mr. Orr, of Bridgewater, Mass., had imported models of machinery from England, Daniel

Anthony went to Bridgewater and obtained a draft of the model which was very imperfect, and not in operation. They also built a machine called a jenny, a model of which had been brought from England into Beverly, Mass., by a man named Somers. This jenny had twenty-eight spindles and was operated in the market house at Providence. They then made a carding machine, and subsequently proceeded to build a spinning frame from the draft obtained at Bridgewater, but it was a failure, being too cumbersome to work by hand and too imperfect to be worked by water. This was the machinery bought by Moses Brown and condemned by Samuel Slater on his arrival in Providence. But notwithstanding the difficulties attending his experiments, and his own depression at the constant failure of his own efforts towards perfection, Mr. Slater evinced so great an ability for this task in the first three months, and there seemed such good prospect of ultimate success, that it was proposed he should enter into partnership with Messrs. Almy and Brown. On the fifth of April, 1790, a contract was drawn up between William Almy and Smith Brown of the one part, and Samuel Slater of the other part, that the first named parties should furnish capital and materials for the construction of two carding machines, a drawing and roving frame, and a spinning frame to the capacity of one hundred spindles, and capital for the carrying on of the manufacture after the completion of the machines; while the last named was to receive one-half the profits of the business and to own one-half the machinery as compensation for his services. Messrs. Almy and Brown were to have a commission of two and one-half per cent for the purchase of stock, and four per cent for selling yarn, and Mr. Slater was to be charged half the expense incurred in the purchase and construction of the machines and for the amounts advanced for his support while developing and prosecuting the business. The style of the firm formed under this contract was Almy, Brown and Slater.

Mr. Slater's new machines were set up in the fulling mill of Ezekiel Carpenter, which stood near the West end of Pawtucket Bridge, and the day on which they were first set in motion marked a new era in manufacturing in New England. The first yarn was probably produced in the autumn of 1790. But the first record of the employment of operatives and the keeping of their time was made on Monday, Dec. 20, 1790.

The success of the enterprise was such that cotton yarn was almost immediately produced, which was fully equal in quality to that of the same grade produced in England, and the firm decided to build a mill especially adapted to cotton spinning. For this purpose, a mill privilege on the Blackstone River, some twenty rods above the Pawtucket Bridge, was purchased Nov. 12, 1791, and early in 1793 the building was begun. The building still stands, though many alterations and additions have been made, and, though it is styled the "Old Slater Mill," as seen from the

street, it does not give a very correct idea of the mill as it was when Samuel Slater was one of its owners.

Hardly was the mill running on a substantial basis, with every promise of unlimited prosperity and success, than dissatisfaction arose among some of the help employed, and several of these employees left and erected for themselves a small mill, the patterns of the machinery were copied by them, and new machines were at divers times and places set in motion by persons drawing their knowledge from Slater's mill in Pawtucket, so that in 1812, more than one hundred factories, operating eighty thousand spindles, had been established in different parts of the country.

The business of Almy, Brown & Slater was for several years confined to cotton spinning, the yarns made by them being sold in the vicinity of the mills, but as similar factories became numerous, a market was sought further afield, and Almy & Brown became the selling agents, the manufacuring being done by Almy, Brown & Slater.

In 1793, Mr. Slater sold the first cotton sewing thread manufactured in the United States. He was showing his wife some warp spun from cotton upon his new machinery, which was then being introduced to take the place of the linen warp which had heretofore been used with cotton filling, when in testing its strength and fineness, she suggested that it might prove an available substitute for the linen sewing thread then in use, and Mr. Slater successfully adopted her suggestion.

Early in 1799, Mr. Slater began the erection of a mill on land owned by him in Rehoboth, and by a transfer of property, later admitted Oziel Wilkinson, Timothy Greene and William Wilkinson into the venture, and the business was carried on under the style of Samuel Slater & Co. This factory was known as the White Mill. In 1819 (Jan. 30) Mr. Slater sold his interest in the business.

When the first cotton factory established by Samuel Slater had been successfully operated for some ten years, desiring the co-operation of his younger brother John, he invited him to come to America. On his arrival in Pawtucket in 1803, he entered the service of Almy, Brown & Slater, and two years later, when the firm decided to start cotton manufacturing in some new location, Mr. John Slater made several prospecting journeys, during which he discovered in the northern part of the town of Smithfield, R. I., the Monhegan, now the branch river, which afforded an exceptionally fine water privilege. Three purchases of land were made, comprising in all more than one hundred and fifty acres, and including the control of the stream. A partnership was formed by William Almy, Obadiah Brown, Samuel Slater and John Slater, under the style of Almy, Brown & Slaters, and the building of the mills was at once begun and completed late in 1806, the machinery being started in 1807. This mill was equipped with all the latest improvements in machinery brought by Mr. John Slater from England, and in September he removed there as superintendent of the

concern, which began spinning in the following spring, and was managed by him for upwards of fifty years. Samuel Slater himself resided during part of his life at Slatersville, a village which was built mainly by his own and his brother's efforts. The establishment there was originally owned by the four partners in equal shares, but eventually became the sole property of John Slater and the heirs of his brother.

In 1808, Samuel Slater & Co., in addition to their output of spinning products, advertised "checks, stripes and tickings of superfine and middling qualities."

In 1811, Mr. Slater was informed by one of his clerks, Bela Tiffany by name, of the existence of a water-power in what is now Webster, Mass. Mr. Tiffany lived in Brimfield, Mass., and passed through this section on his journeys to and from Pawtucket, and upon mentioning the fact of the water-power to Mr. Slater, the latter suggested that he stop off and ascertain its situation and quality. In a letter of May 27, 1811, the young man wrote informing Mr. Slater, that in an almost benighted region, four miles from Oxford, three miles from Dudley, and six and a half miles from Thompson, Connecticut, he had found about thirteen acres of land with certain buildings thereon and a "waterfall sufficient for all practicable purposes." Before the close of the year 1812, about two hundred and sixty more acres had been added, mills were at once erected, and in 1813, Slater and Tiffany (Mr. Tiffany was now a partner with one-sixth interest) began the manufacture of cotton yarn. At the same time, a dyeing and bleaching house was erected and placed under the management of John Tyson, who had an interest in the business until his death in 1821, when it passed into the hands of Mr. Slater. Other purchases of land were made by Slater & Tiffany during 1814-15, but in November, 1816, during the depressed condition of manufactures and the financial stress occasioned by the war of 1812, Mr. Tiffany sold his interest to Mr. Slater. During the war, the company had engaged in the manufacture of woolen cloth under the superintendence of Edward Howard, a Yorkshire man, and through his influence a new location was made on French River, where a property of twelve thousand dollars was bought, and Mr. Howard in 1822 conveyed half his interest to Mr. Slater.

Further purchases of land were made on French River, amounting to more than five hundred acres between 1822-24. In 1823, Mr. Slater purchased the cotton mills of Braman, Benedict & Waters at what is now the North Village of Webster. The several villages to which these manufacturing interests afforded nurture, with some additional territory taken from the towns of Dudley and Oxford, were through Mr. Slater's influence incorporated as the town of Webster, named in honor of the great statesman, of whom Mr. Slater was an ardent admirer.

In 1823, on the tenth of July, Samuel Slater, with his brother John, bought the cotton mills at Jewett City, Conn., which plant was operated by

the Jewett City Manufacturing Co., the enterprise proving successful under the Slater management. July 23, 1831, Samuel Slater conveyed his interest in this property to his brother John, who from that time until his death owned and operated the mills.

In May, 1826, Samuel Slater became the owner of a half interest in the Amoskeag Village Mills, N. H., his partners being Larned Pitcher of Seekonk, Mass., and Ira Gay, of Dunstable N. H. and in December of the same year, Messrs. Slater, Pitcher and Gay with Oliver Dean, of Medway, Mass., Lyman Tiffany, of Roxbury, Mass., and Willard Sayles, of Boston, Mass., entered into partnership under the firm name of the Amoskeag Manufacturing Company, and operated the two mills until July 1, 1831, when a charter of incorporation was granted by the New Hampshire legislature, under the same name, the partners conveying their interest to the company and receiving shares in return. Mr. Slater was a stockholder in this company until his death.

In 1829, Mr. Slater conveyed his interest in the Slatersville Mills to his partners, but he repurchased it in 1832, and with it, in partnership with his brother John, he bought the interests of the other partners, after which time the mills at Slatersville were operated by the firm of S. & J. Slater. On August 12, 1829, the partnership of Almy, Brown & Slater, at Pawtucket, was dissolved, Mr. Slater selling his interest to his partners.

In 1829, Mr. Slater became sole proprietor of the woolen mill in Webster, which up to that time he had carried on in partnership with Mr. Howard. In 1830, he became the proprietor of the Providence Steam Cotton Mill, which had been erected some years before, largely with capital furnished by him, and also of the mills at Wilkinsonville, Mass., which had been built in 1823 by David Wilkinson, who became insolvent in 1829, and of whom he was the largest creditor. His interest in these mills descended to his heirs.

Though for more than twenty years after coming to this country he still had labored for sixteen hours a day, Mr. Slater found time and thought for those in his employ. On the establishment of the old mill in Pawtucket, he introduced such rules and regulations as he thought expedient for the enforcement of order and regularity, and also opened Sunday schools after the manner of those established by Mr. Raikes in England, for the instruction of the young people employed in the mills; in addition to these, day schools were promoted by Mr. Slater at all of the manufactories in which he was interested, in some cases the teachers' salaries being paid by Mr. Slater himself, and his relations with his employees were cordial and pleasant. He took a paternal and kindly interest in their welfare, which was extended to their social and domestic concerns, and to his care and effort for a period extending over forty years, was due the relatively superior condition of the manufacturing villages of Rhode Island in their moral and social aspects as compared with similar manufacturing villages

Augustus Lowell

of that time in Great Britain. He was especially winning and genial with youth and children, and his paternal relations with his own children were peculiarly tender.

His ideas were broad, far-reaching and philosophical, and he deserved in an eminent degree the place he holds in New England as the one who gave direction and impetus to the movement which early in the nineteenth century placed the United States on a manufacturing eminence, and opened out to her, in the textile industries, possibilities that are still unlimited. Mr. Slater was several times honored by the thanks and appreciation of the nation, formally expressed by a unanimous vote in Congress for the inestimable benefits he had conferred in fostering the manufactures of the infant republic. In person he was tall and well proportioned, of light complexion, ruddy countenance, regular features and intellectual expression.

He was a citizen of Pawtucket up to the time of his death, though his later years were passed mostly in the mansion he had built at East Webster.

Mr. Slater married, shortly after he had settled in Providence, Hannah, daughter of Mr. Oziel Wilkinson, with whom he was associated in business. The marriage took place Oct. 2, 1791, and of it were born nine children: William, born Aug. 31, 1796, died Jan. 31, 1801; Elizabeth, born Nov. 15, 1798, died Nov. 4, 1801; Mary, born Sept. 28, 1801, died Aug. 19, 1803; Samuel, born Sept. 28, 1802, died July 14, 1821; George Basset, born Feb. 12, 1804, died Nov. 15, 1843; John, born May 23, 1805, died Jan. 23, 1838; Horatio Nelson, born March 5, 1808, died Aug., 1888; William, born Oct. 15, 1809, died Sept., 1825; Thomas Graham, born Sept. 19, 1812, died Sept., 1844.

Mrs. Slater died, aged thirty-eight, soon after the birth of her youngest child, and Nov. 21, 1817, Mr. Slater married Esther, widow of Robert Parkinson, and she survived him. Samuel Slater died at Webster, Mass., April 21, 1835, in his sixty-seventh year.

AUGUSTUS LOWELL.

Augustus Lowell was born in Boston, Mass., Jan. 15, 1830. He was the son of John Amory and Elizabeth (Putnam) Lowell. Augustus Lowell passed his boyhood in Roxbury, attended the Boston Latin School, where he was prepared for college, and was graduated from Harvard in the Class of 1850. He travelled in Europe, visiting England, France, Germany and Switzerland, and, on returning to Boston, found a position in the counting room of Bullard & Lee, East India merchants, where he remained from 1852 to 1853. He then was sent to Lowell (which place was named after his great-uncle, Francis Cabot Lowell) to obtain a prac-

tical knowledge of the business of cotton manufacturing, and, after spending a year in the mills there, he returned to Boston and was employed in the office of J. M. Beebe, Morgan & Co. He was almost constantly officially connected with the cotton mills at Lowell and Lawrence, and was also engaged in the East India trade in partnership with Franklin H. Story. With his wife and family he visited Europe, 1864-66, tarrying for two and a half years on account of Mrs. Lowell's health. Returning to Boston in 1866, he continued the care of the cotton manufacturing interests and assumed the management of numerous trusts. In 1875 he was chosen treasurer of the Boott Cotton Mills, an office which he held for eleven years, and about the same date was elected to succeed his father on the board of the Massachusetts Hospital Life Insurance Company. Of the Provident Institution for Savings he was likewise made a member, and eventually became its president, and at this date also began his long career upon the board of the Boston Gaslight Company. He was also treasurer of the Merrimack Manufacturing Company, June 20 to October 29, 1877; president of the Massachusetts Cotton Mills; of the Massachusetts Mills, in Georgia; of the Pacific Mills; of the Merrimack Manufacturing Company, 1887-8 and 1892, to death; of the Boott Cotton Mills; of the Lowell Bleachery; of the Lowell Machine Shop; of the Glendon Iron Company, and a director of the Everett Mills; of the Middlesex Company; of the Lawrence Mills; of the Lowell Manufacturing Company; of the Suffolk National Bank; of the Cranberry Iron Company; of the Plymouth Cordage Company, and of the Union Trust Company of New York, taking a leading part in the direction of all the companies with which he was associated.

Aside from these widely varying business interests, Mr. Lowell took an active interest in matters affecting the public welfare. For many years he was a trustee of the Boston Eye and Ear Infirmary, and participated actively in its management. He followed his father as trustee of the Lowell Institute and did much for its prosperity: and he largely shaped the policy of the Massachusetts Institute of Technology as a member of the corporation from 1873 to 1883, and as a member of its executive committee from 1883 to 1901. He was made a member of the American Academy of Arts and Sciences in 1886, of which he was also treasurer and then vice-president. He was also a member of the American Association for the Advancement of Science from 1898; of the Massachusetts Historical Society in 1900; of the Colonial Society of Massachusetts from 1898; ex-officio, he was a trustee of the Boston Art Museum for twenty years and a trustee of the Lowell Textile School from 1897 to the time of his death. Mr. Lowell's son, Mr. Percival Lowell, wrote a memoir of him which was published in the "Proceedings of the American Academy of Arts and Sciences," Vol. xxxvii, from which we quote the following as of special interest: "Three qualities he possessed to an unusual degree—will, ability and integrity. He was noted for his determination. To his lot, in consequence,

fell many necessary and thankless tasks. He likewise escaped many empty honors. For where he went, he worked. No one ever thought of preferring him to a post merely *honoris causa*. For people knew that in getting him they got not a figurehead, but a man who was certain to make himself felt; not because he tried to do so, but because it was in him to do it."

Mr. Lowell married, June 1, 1854, Katharine Bigelow, seventh and youngest child of the Hon. Abbott (1792-1855) and Katherine (Bigelow) Lawrence, and their children were: Percival Lowell, born in Boston, March 13, 1855, astronomer; Abbott Lawrence Lowell, born in Boston, December 13, 1856; elected president of Harvard in 1909; Katharine Lowell, born in Boston, November 27, 1858, married Alfred Roosevelt, who died in 1891, and, secondly, November 24, 1902, Thomas James Bowlker; Elizabeth Lowell, born in Boston, February 2, 1862, married June 9, 1888, William Lowell Putnam, lawyer, of Boston; Roger Lowell, born in Boston, February 2, 1862, died August 31, 1863; May Lowell, born May 1, 1870, died same day; Amy Lowell, born in Brookline, February 9, 1874. Mr. Lowell died at his home in Brookline, Mass., June 22, 1901.

FRANCIS CABOT LOWELL.

Francis Cabot Lowell was born in Newburyport, Mass., April 7, 1775. He was the son of Judge John and Susanna (Cabot) Lowell, grandson of the Rev. John and Sarah (Champney) Lowell and of Francis and Mary (Fitch) Cabot, and a descendant of Percival Lowell, who came from Bristol, England, in 1639, and settled in Newbury, Mass.

Francis Cabot Lowell was graduated from Harvard, A. B. 1793 and M. A. 1796. He then engaged in mercantile pursuits in which he was remarkably successful. In 1810 the condition of his health induced him to visit England. On his return to America, shortly after the commencement of the War of 1812, he, with his brother-in-law, Patrick Tracy Jackson, undertook the manufacture of cotton on what was then a large scale. Unable to obtain a power loom, such as was then in use in England, Mr. Lowell and Mr. Jackson spent the winter of 1812-13 in the construction of such a loom, in which they were eminently successful, and immediately formed the Boston Manufacturing Company with an authorized capital of $400,000. Mr. Nathan Appleton was associated with Mr. Lowell and Mr. Jackson in this venture, and a mill was immediately built at Waltham, Mass. In the mean time, the joint inventors were busily engaged in perfecting this loom, for which they obtained a patent February 23, 1815. A number of looms had been placed in the Waltham Mill, and Mr. Lowell, unable to obtain the requisite supply of yarn of a uniform quality,

established there also a spinning mill of 1700 spindles, and thus the first factory making finished cloth from the raw cotton was established.

The close of the War of 1812, in 1814, however, had a very injurious effect on the cotton industry of New England, and when Mr. Lowell, in company with Mr. Appleton, visited the mills in Rhode Island, they found the owners clamorous for a very high tariff. In 1816 Mr. Lowell went to Washington to aid in procuring such a tariff as would protect New England cotton mills, but he found the representative and senators in Congress from these states hostile to his scheme on account of the opposition offered by the merchants largely engaged in the carrying trade with the East Indies, who dealt largely in cotton cloth manufactured in the East. Mr. Lowell therefore turned to the members from the Southern States, and through them obtained a minimum duty of six and one-quarter cents per square yard, which tariff set the spindles and looms of New England in motion again. Thus was Mr. Lowell mainly instrumental in the permanent establishment of the cotton industry in New England.

After his death his brother-in-law, Patrick Tracy Jackson, purchased a section of Chelmsford, and, with John Amory Lowell, located mills there, and the new manufacturing centre for Northern Massachusetts became known as Lowell, in commemoration of Francis Cabot Lowell, the town being incorporated in 1826.

Mr. Lowell married Hannah, daughter of the Hon. Jonathan and Hannah (Tracy) Jackson, October 31, 1798, and had three sons and one daughter. His son John left $250,000 for a course of lectures which resulted in the founding of the Lowell Institute in 1836. Francis Cabot Lowell died in Boston, Mass., August 10, 1817.

JOHN AMORY LOWELL.

John Amory Lowell was born in Boston, Mass., Nov. 11, 1798. He was the son of John (1769-1840) and Rebecca (daughter of John and Katharine Greene Amory) Lowell and grandson of John and Sarah Higginson Lowell.

John Amory Lowell was graduated from Harvard, A. B. 1815, A. M. 1818, and received his business education in the house of Kirk Boott & Sons, to whose business he succeeded in partnership with the eldest son, Mr. John Kirk Boott. In 1827 he was treasurer of the Boston Manufacturing Company, at Waltham, and in 1835 built the Boott Mill at Lowell, and was treasurer of the Boott corporation for thirteen years and president and director up to the time of his death.

In 1839 he built the Massachusetts Mills, at Lowell, of which he was

Faithfully Yours
Amos A Lawrence

treasurer from its inception to 1848, and a director throughout his life. From 1871-77, he was president of the Pacific Mills, and was also a director of that corporation. He was associated with Abbott Lawrence and others in the founding of the Essex Company at Lawrence. He was also a director of the Lowell Machine Shop, of the Lake Company, and for fifty-nine years a director of the Suffolk Bank, Boston, in which connection he originated the system of redemption of country bank notes.

From Harvard, Mr. Lowell received the honorary degree of LL.D. in 1851. He was a Fellow of Harvard College, 1837-77, member of the Linnean Society of London, England, Fellow of the American Academy of Arts and Sciences and member of the Massachusetts Historical Society. He was a member of the convention that revised the State Constitution in 1853, and was connected with various benevolent and literary associations. Under the will of John Lowell, Jr., he was sole trustee of the Lowell Institute for forty years, and as such was responsible for its founding and development and for the institution of its lecture courses, its free drawing school, its lectures for advanced classes in the Massachusetts Institute of Technology, its courses of instruction in science for the teachers of Boston, and the Lowell School of Practical Design, established in 1872.

He married in Boston, Feb. 14, 1822, Susan Cabot, second child of Francis Cabot and Hannah (Jackson) Lowell. She died at Cambridge, Mass., August 15, 1827, and he married secondly, April 2, 1829, Elizabeth Putnam, daughter of Hon. Samuel and Sarah (Gooll) Putnam, of Salem, Mass., and had one son, Augustus Lowell, born Jan. 15, 1830.

John Amory Lowell died in Boston, Mass., Oct. 31, 1881.

AMOS ADAMS LAWRENCE.

Amos Adams Lawrence was born in Boston, Mass., July 31, 1814; son of Amos and Sarah (Richards) Lawrence; grandson of Samuel and Susanna (Parker) Lawrence, of Groton, and of Giles and Sarah (Adams) Richards, of Dedham; great-grandson of Captain Amos and Abigail (Abbott) Lawrence, of the Rev. Amos and Elizabeth (Prentiss) Adams, of William and Sarah (Richardson) Parker, of Groton, and of Abigail and Hulda (Hopkins) Richards, of Waterbury. His first ancestors in America included John and Elizabeth Lawrence, Watertown, Massachusetts Bay Colony, 1635, and Groton, 1662; Thomas Richards (1600-1639), of Hartford Colony, and Henry and Elizabeth (Paine) Adams, Medfield, Massachusetts. Amos Lawrence (1786-1852) was a member of the firm of A. & A. Lawrence, extensive promoters of the early woolen and cotton mill enterprise of New England.

The subject of this sketch, Amos Adams Lawrence, was prepared for college in Boston. and at Franklin Academy, North Adams, and was graduated from Harvard, A. B. 1835, A. M. 1838; was treasurer of the Corporation of Harvard College, 1857-62, and an overseer, 1879-85. His business career began in 1835 as a clerk in the dry goods commission house of Almy Patterson & Co., of Boston, in 1835; commission merchant on his own account, 1836-9; member of the commission firm of Mason & Lawrence, 1843-6, and of Lawrence & Co., 1846-86. He was president of the Cocheco Cotton Manufacturing Company, East Rochester, N. H., and treasurer of the Salmon Falls Manufacturing Company, Salmon Falls, N. H., the firm of Lawrence & Co. being the selling agents for these mills, and for the Pacific Mills, Lawrence, Mass., for more than forty years. He was a director of the Suffolk Bank, of Boston; of the American Insurance Office; of the Massachusetts Hospital Life Insurance Company; of the Boston Water Power Corporation; of the Amesbury Company; of the Middlesex Canal; of the New England Trust Company, of which he was the first president; of the National Association of Cotton Manufacturers and Planters, and of the Association of Knit Goods Manufacturers, serving both these associations as president.

In 1846 he purchased a large tract of land in Eastern Wisconsin, and founded the town of Appleton, on the banks of the Fox River, which became the capital of Outagamie County and the seat of Lawrence University, which he founded in 1849, and of which he was the chief benefactor during his lifetime. He was a member of the Massachusetts Historical Society and of various benevolent associations. He was treasurer and one of the three trustees of the New England Immigrant Aid Company, active from 1854 in supporting the Free Soil Party in Kansas in their struggle to prevent the establishment of slavery in the territories of Kansas and Nebraska. It was mainly due to his personal aid and the efforts of Eli Thayer, of Worcester, that Kansas became a free state. In 1860 he was the candidate of the Union Party for Governor of Massachusetts, and when the Civil War was apparent, he devoted much time and money to military drill and in instructing college students in the manual of arms. He was the leader in recruiting the Second Regiment Massachusetts Volunteer Cavalry in the fall of 1862, and in 1863 he was appointed by Governor Andrew to organize and recruit the Fifty-fourth Massachusetts Regiment, composed of colored men recruited in Boston.

He acted as chairman of the finance committee which raised the fund to erect Memorial Hall at Cambridge, in honor of the sons of Harvard who were killed in the service during the Civil War. He was the first treasurer of the Episcopal Theological School at Cambridge, and served in that office for fifteen years. In 1873 he built and presented to the school one-half of the stone dormitory, known as Lawrence Hall, and he completed the building in 1880. Mr. Lawrence married March 31, 1842, Sarah

Elizabeth, daughter of the Hon. William and Mary Ann (Cutter) Appleton, and they resided in Pemberton Square, Boston, removing in 1851 to Cottage Farm, Brookline, where he acquired a large landed property, and where, in 1867, in connection with his brother, William Richard Lawrence, he built the Church of Our Saviour, Longwood, in memory of their father, the beautiful church being consecrated by Bishop Eastborn, September 29, 1868. In 1885 his widow added to the gift a stone rectory; and in 1893 their children erected a transept of the church as a memorial of their mother who died at Longwood, May 27, 1891. The children of Amos Adams and Sarah Elizabeth (Appleton) Lawrence were: Marianne Appleton, who married Dr. Robert Amory; Sarah, who married Peter Charles Brooks; Amory Appleton, born April 22, 1848; William, born May 30, 1850, Bishop of Massachusetts; and Susan, who married William Cabot Loring. Amos Adams Lawrence died at his summer home at Nahant, Mass., August 22, 1886.

AMOS LAWRENCE.

Amos Lawrence was born in Groton, Mass., April 22, 1786, the fourth son of Major Samuel and Susanna (Parker) Lawrence and brother of Abbott Lawrence (1792-1855). He attended the public school in Groton and then spent a term at Groton Academy, leaving school at the age of thirteen to take a position as clerk in a store at Dunstable, where he remained less than a year. He then served an apprenticeship of seven years in the general variety store of James Brazer, in Groton, and his next position was as clerk in a Boston drygoods store. This firm, within a few months failed, and Mr. Lawrence was appointed by the creditors to settle its affairs. This being satisfactorily accomplished, he, December 17, 1807, began business on his own account, opening a small drygoods store on Cornhill. The following year he was joined by his brother Abbott, who served as his apprentice. January 1, 1814, the two brothers formed the firm of A. & A. Lawrence, and, as a partner, the subject of this sketch became interested in the manufacture of domestic goods and in promoting enterprises at Lowell and Lawrence, Mass., the firm becoming large owners in the first mills erected in these towns. These two brothers, in establishing the commission house of A. & A. Lawrence, not only laid the foundation of their own fortunes, but that of many of the members of the Lawrence family.

In 1831, on account of ill-health, Amos Lawrence retired from active participation in business and devoted the remainder of his life to philanthropic works. He gave $40,000 to Williams College, and the library of

the college was named "Lawrence Hall" in his honor. He founded a library for Groton Academy, giving to the school a valuable telescope, and, at the time of his death, was engaged in raising $50,000 as an endowment fund for the academy. In 1846 the name was changed to Lawrence Academy on account of his munificent gifts. He gave generously to Kenyon College, Ohio; to Wabash College, Indiana, and to Bangor Theological Seminary, Maine. He established a Children's Infirmary in Boston, donated a building to the Boston Society of Natural History and contributed $10,000 towards completing Bunker Hill Monument. His fame as a merchant caused his name to be placed among the candidates in "Class B Merchants" as worthy of a place in the Hall of Fame for Great Americans in October, 1900, and twenty votes were given him, the only candidate receiving a greater number being Cornelius Vanderbilt, who received twenty-nine votes, but, as fifty votes were necessary to secure a place, the name of no merchant appears in the Hall. He served as a representative in the General Court of Massachusetts, 1822.

Mr. Lawrence was twice married; first to Sarah Richards, June 6, 1811, and second to Mrs. Nancy Ellis, widow of Judge Ellis, of Claremont, N. H., and daughter of Robert Means, of Amherst, N. H. Mr. Lawrence died in Boston, December 31, 1852.

ABBOTT LAWRENCE.

Abbott Lawrence was born in Groton, Mass., December 16, 1792, fifth child of Samuel and Susanna (Parker) Lawrence and younger brother of Amos Lawrence (1786-1852) (q. v.). He attended the district school, and subsequently, for three years, Groton Academy, and worked on his father's farm during the vacation periods. In 1808 he went to Boston, where he was apprenticed to his brother Amos in the drygoods business, and on reaching his majority, December 16, 1813, became a partner in the business, the firm of A. & A. Lawrence, importers and dealers in foreign woolen and cotton goods, being formed January 1, 1814. In 1812 he assisted in organizing the New England Guards, and rendered service in the Charlestown Navy Yard and elsewhere during the war with Great Britain, for which service he received a grant of land from the government. During his repeated trips to England to purchase goods, he became alive to the necessity of manufacturing in the United States, and joined the men who first proposed to erect factories on the Merrimack River at Lowell. He led the distinguished company, including William and Samuel Lawrence, John A. Lowell, Francis C. Lowell, Nathan Appleton, Theodore Lyman, George W. Lyman, Patrick T. Jackson, James B. Francis and Charles S.

Storrow, in organizing the Merrimack Water Power Association, of which he was made president and Mr. Storrow treasurer and agent, and in his honor and that of his brothers, Samuel and William, Bodwell Falls became known as Lawrence and was incorporated as a town in 1847. The Atlantic Mills were chartered in 1846 and three mills erected in 1849-52 for the manufacture of sheetings and shirtings, which were sold by the firm of A. & A. Lawrence. Abbott Lawrence was elected the first president of the corporation, and when the Pacific Mills was formed and incorporated he became president of that corporation also, and so continued up to the time of his death, in 1855.

He was largely interested in political affairs, and served as one of the seven delegates from New England to the Harrisburg Tariff Convention of 1827; was a member of the Common Council of Boston, 1832, declining re-election; was a Whig representative from Massachusetts in the Twenty-fourth Congress, 1835-37, serving on the Ways and Means Committee; declined to stand for the next election, but was elected to the Twenty-sixth Congress, taking his seat in 1839, but was obliged to resign in September, 1840, on account of ill-health. He was the United States Commissioner to settle the Northeastern boundary question in 1842 with Lord Ashburton, the representative of Great Britain. He was a delegate to the Whig National Convention at Baltimore, Md., May 1, 1844, and to the National Convention of 1848. He accepted the position of United States Minister to England, but resigned in 1852 and returned to Boston. He gave $50,000 to endow the Lawrence Scientific School, Harvard University, and bequeathed $50,000 for the erection on East Canton Street, Boston, of model lodging houses for the poor; $10,000 to the Boston Public Library, and $50,000 to the Lawrence Scientific School. He received the honorary degree of LL. D. from Williams College in 1852 and from Harvard College in 1854, of which body he was an overseer, 1854-55, a member of the Massachusetts Historical Society and a fellow of the American Academy of Arts and Sciences. He married June 28, 1819, Katharine Bigelow (1793-1860), eldest daughter of Hon. Timothy and Lucy (Prescott) Bigelow, granddaughter of Col. Timothy and Anna (Andrew) Bigelow, of Worcester, Mass., and of Dr. Oliver and Lydia (Baldwin) Prescott, of Groton, Mass., and their children were: Annie Bigelow, who married Benjamin Smith Rotch, of New Bedford, Mass., July 30, 1846; James, who married Elizabeth, daughter of William Hickling Prescott, the historian, and Sarah (Amory) Prescott, March 16, 1852; George (April 16, 1824-August 7, 1824); John Abbott (June 11, 1825-June 22, 1825); Timothy Bigelow (1826-1869), Harvard College A. B. 1846, A. M. 1849, attaché of the American Legation at London, England, 1849-55; on staff of General E. D. Keyes, Army of the Potomac, 1861; consul-general to Florence, Italy, 1862-69.

A public memorial service was held in Faneuil Hall, August 20, 1855,

at which the Hon. Robert C. Winthrop, Hon. Edward Everett and other of the leading men of New England eulogized his character and services. Abbott Lawrence died in Boston, Mass., August 18, 1855.

AMORY APPLETON LAWRENCE.

Amory Appleton Lawrence was born in Boston, Mass., April 22, 1848. He was the son of Amos Adams and Sarah Elizabeth (Appleton) Lawrence. (For genealogy see sketch of his father, *Ibid.*)

He attended school in Brookline and Boston, and was graduated from Harvard University, A. B. 1870, and in the same year entered the house of Lawrence & Co., drygoods commission merchants. In 1871 he was admitted to the firm, and, as a member of it, became a large investor in cotton manufacturing enterprises. He was director of the Ipswich Mills, 1870; treasurer, October, 1870, to October, 1873, and president from 1876. A director of the Gilmanton Mills, Belmont, N. H., from 1875, and was made president of that corporation in 1886. He was a director of the Salmon Falls Manufacturing Company, Salmon Falls, N. H., from 1886, and president from 1894; a director of the Pacific Mills. Lawrence, Mass., from 1884; a director of the Dwight Manufacturing Company. Chicopee, Mass., from 1884; director of the Cocheco Manufacturing Company, Dover, N. H., from 1886, and treasurer of the Groton Water Company from 1897 to 1900. The Boston Merchants' Association, of which he was a member, at their annual meeting in January, 1901, elected him president of the association; and in March, 1902, he was one of three Boston merchants selected as a committee to settle the teamsters' strike which threatened to paralyze the city trade, and, with the aid of Governor Crane, in a single night's conference with the strikers settled the difficulty. Mr. Lawrence was a member of the managing board of the Boston Episcopal Charitable Society, and in 1891 he was made treasurer of the society. He was also director of Boston Manufacturing Co., of Waltham, from 1904; director of Waltham Bleachery and Dye Works from 1904. He was also vice-president of Massachusetts Hospital Life Insurance Co.; trustee Provident Institution for Savings of Boston; trustee of the Church Home for Orphan and Destitute Children at South Boston; vice-president of the Perkins Institute for the Blind at South Boston; vice-president of the Industrial School for Crippled Children, of Boston.

Mr. Lawrence was a member of the managing board of the Boston Episcopal Charitable Society, and in 1891 he was made treasurer of the society. Harvard Class of 1870 made him chairman of the Class Committee in 1870, and he was elected overseer of Harvard College in 1906 for five

years. He married, June 1, 1871, Emily Fairfax (daughter of John Boardman and Martha Mansfield (Shepard) Silsbee), and their son, Amos Amory Lawrence, was born in Boston, December 1, 1874; was prepared for college at St. Paul's School, Concord, N. H.; was graduated at Harvard University A. B. 1896; was a postgraduate student at Massachusetts Institute of Technology, 1896-97, in the Department of Architectors; studied at the Ecole des Beaux Arts in Paris, and there obtained his diploma in June, 1905. Their second child, John Silsbee Lawrence, was born at Nahant, Mass., September 6, 1878. (See sketch, *Ibid.*) Their third child, Edith, born in Boston, November 10, 1879, married, February 19, 1903, Harold Jefferson Coolidge (Harvard, 1892), son of Joseph Randolph and Julia (Gardner) Coolidge, and a lineal descendant of Thomas Jefferson, third president of the United States. He became a member of the firm of Loring & Coolidge, of Boston, and their sons are Harold Jefferson Coolidge, Jr., born January 15, 1904, and Lawrence Coolidge, born January 16, 1905. Mrs. Lawrence died in Boston, April 4, 1895, and Mr. Lawrence married (secondly), at Groton, Mass., June 12, 1900, Gertrude Major, daughter of Francis Blake and Sallie Blake (Austin) Rice, of Boston, and she died in Boston, January 11, 1907. In April, 1911, he married (third), Mrs. Laura Amory Dugan, daughter of General Thomas I. C. and Mary (Dolan) Amory; adopted daughter of Charles B. Amory, and widow of Thomas Clay Dugan.

JOHN. S. LAWRENCE.

John Silsbee Lawrence was born in Nahant, Mass., September 6, 1878, the son of Amory A. and Emily Fairfax (Silsbee) Lawrence. Prepared for college at Noble and Greenough's School, Boston, he entered Harvard and was graduated, A. B., in the class of 1901. He then decided to adopt a mercantile profession, and entered as clerk the firm of Lawrence & Co., of which his father was senior member, and in 1906 John S. Lawrence was admitted to partnership.

In 1907 he became a director of the Second National Bank of Boston; in 1908 a director of the American Trust Co.; in 1907 a trustee of the Suffolk Savings Bank, and in 1910 a director of the New England Casualty Co.

As a member of the Chamber of Commerce, he took great interest in Boston's fuel supply, and was one of the leaders in securing for Boston an efficient smoke bill in 1910.

Mr. Lawrence married, April 29, 1907, Emma, daughter of Isabelle (Ray) and George E. Atherton, of Brookline, Mass., and on February 6, 1910, their first child, Eloise, was born.

PATRICK TRACY JACKSON.

Patrick Tracy Jackson was born in Newburyport, Essex County, Massachusetts, August 14, 1780. He was the son of Jonathan and Hannah (Tracy) Jackson, grandson of Edward and Dorothy (Quincy) Jackson; great-grandson of Jonathan and Mary (Salter) Jackson; great-great-grandson of Jonathan Jackson and great-great-great-grandson of Edward Jackson, who came from England to Massachusetts Bay Colony about 1643 with his wife and Jonathan and settled in Cambridge, was deputy to the General Court, 1647-54, and eleven times in later years selectman and one of the proprietors of the town of Cambridge. Patrick Tracy Jackson's father, the Hon. Jonathan Jackson (1743-1810) was born in Boston; graduated from Harvard, 1761; settled in Newburyport about 1762 as a merchant; was a delegate to the provincial Congress of 1775; delegate to Continental Congress, 1782; United States Marshal under President Washington, 1789-91; treasurer of Massachusetts, 1805-1810; the first president of the first bank established in Boston; treasurer of Harvard corporation and fellow of the American Academy of Arts and Sciences, 1807-10. He married, January 3, 1767, Sarah Barnard, and secondly, June 1, 1772, Hannah, daughter of Captain Patrick Tracy.

Patrick Tracy Jackson was educated in the Newburyport Public Schools and Dummer Academy. In 1795 he was apprenticed to William Bartlett, a shipping merchant, and from 1800 was repeatedly sent as supercargo to the East Indies, and in 1808 was engaged in the East India trade on his own account in Boston, in which he amassed a large fortune. His sister, Hannah, married Francis Cabot Lowell (q. v.), and this marriage brought the two men into intimate business relations. Lowell, who had studied the working of the power loom used in England in weaving cotton cloth, sought the assistance of Mr. Jackson in constructing a loom, with the object of engaging in the extensive manufacture of cotton in New England. Lowell had but a vague knowledge of the construction of the English loom, but he imparted what information he had to Mr. Jackson, and the two men invented the model from which Paul Moody constructed the first power loom used in the United States. In 1813 they organized the Boston Manufacturing Company and rebuilt an old mill at Waltham in which the loom was set in motion by the water power of the Charles River, and 1,700 spindles were installed to furnish yarn for the loom. While other mills had already spun cotton yarn by mechanical power, this was the first mill to produce cotton cloth from raw cotton both spun and woven by machinery under one roof, thus constituting a complete cotton mill operated by water power. In 1821 Mr. Jackson purchased land on the Merrimack River at East Chelmsford, on the Pawtucket Canal (Mr. Jackson had designed and built the Pawtucket dam), organized and became first president of the Merrimack Manufacturing Company. The machinery of this company was

P. T. Jackson

set in motion in September, 1823. This enterprise and the Appleton Mills, which began operations in 1828, were the nucleus of the great cotton manufacturing city of Lowell.

In 1830 Mr. Jackson laid the foundation of another important work in securing the charter of and organizing the Boston and Lowell Railroad. A great deal of the property between Boston and Lowell was owned by the Locks and Canals Company, and, believing that the railroad would enhance the value of the land, the company offered a bonus of $100,000 to whatever company engaged in the construction of same. Mr. Jackson, in company with Mr. Boott and Mr. Moody, had a general survey of the district made, and estimated the expense, income, etc. It was decided that the road should be built, and those interested looked to Mr. Jackson as constructor. Work was commenced in 1831, and May 27, 1835, the road was opened; the first trains ever drawn by the locomotive. It was a wonderful advance in the mode of land transportation of both passengers and freight, and was used as a model for construction and equipment of the roads that rapidly followed. In the course of a few years, with business constantly on the increase, greater accommodations had to be made. Mr. Jackson had anticipated the necessity of two tracks over the road, and his plans were carried out, and car houses, freight houses, yards and depots were built and increased. For several years Mr. Jackson gave exclusive attention to the railroad and collateral undertakings. In the progress of his great work, the fact is worthy of mention that he levelled the top of Beacon Hill, Boston, and made the land where the present North Station stands.

In 1837 came a dark period. The panic of that year impaired a great part of his fortune. In April, 1838, however, he was offered and accepted the agency of the Locks & Canals Co., and retained that office until September, 1845. In September, 1840, he was invited to become agent of the Great Falls Manufacturing Company. He accepted, and immediately devised a plan by which this company might retrieve at least a portion of its fortune lost in the panic. He conducted the affairs of the company successfully for many years, which resulted in large dividends during the period of his agency.

In 1810 Mr. Jackson married Lydia, daughter of Andrew and Lydia (Dodge) Cabot, of Beverly, Mass., and their children were: Anna Cabot (Jackson) Lowell, Sarah Cabot (Jackson) Russell, Patrick Tracy Jackson, Hannah Lowell (Jackson) Cabot, Catherine Cabot (Jackson) Stone, Eleanor Jackson and Edward Jackson.

Patrick Tracy Jackson, "the pioneer cotton manufacturer," died at Beverly, Mass., September 12, 1847.

PATRICK TRACY JACKSON (2d)

Patrick Tracy Jackson (2d) was born at Watertown, Mass., November 5, 1818, son of Patrick Tracy and Lydia (Cabot) Jackson. (For genealogy see sketch of his father, *Ibid.*) The subject of this sketch attended private schools in Boston, and was graduated from Harvard, A. B., 1838, A. M., 1841. On leaving college he entered the counting house of James K. Mills & Co., in Boston; was made a partner, the firm name being changed to C. H. Mills & Co., and remained with that house up to 1857. He was manager of the Hampden Mills, 1852-75, and while in that position introduced the manufacture of fine ginghams into this country and was also a cotton buyer in Boston, 1875-86. He served the city of Boston as councilman.

Mr. Jackson married March 23, 1843, Susan Mary, daughter of Charles Greely (1794-1867) and Anna Pierce (Brace) Loring. They had four children: Patrick Tracy Jackson (3d), who married Eleanor B. Gray and was president of the Lowell Weaving Company in 1906; Charles Loring Jackson, born April 4, 1847, Harvard A. B. 1867, A. M. 1870, assistant in chemistry Harvard Universisty 1867-71, assistant professor of chemistry 1871-81, student under Bunsen, Heidelberg, 1873, under Hofmann, Berlin, 1874-75, full professor of chemistry at Harvard, 1881-94, and Erving professor of chemistry from 1894, fellow of the American Academy of Arts and Sciences, member of the National Academy of Science and of the American Association for the Advancement of Science, associate fellow of the British Association for the Advancement of Science; Anna Pierce Jackson; and Ernest Jackson, Harvard A. B. 1878, A. M. 1879.

Patrick Tracy Jackson (1818-1891) died at Beverly, Mass., November 10, 1891.

PATRICK TRACY JACKSON (4th)

Patrick Tracy Jackson (4th) was born in Cambridge, Mass., November 7, 1872; son of Patrick Tracy and Eleanor B. (Gray) Jackson. (For genealogy see sketch of great-grandfather, *Ibid.*) The father of Patrick Tracy, the subject of this sketch, was first lieutenant in the Fifth Massachusetts Cavalry during the Civil War, became a cotton broker and was trustee of estates, treasurer of the Boston Provident Association, of the Eastern Yacht Club, and president and director of the Lowell Weaving Company, of Lowell, Mass., in 1906.

Patrick Tracy Jackson (4th) was prepared for college at the Browne & Nichols School in Cambridge, and was graduated from Harvard Col-

lege, A. B., 1893. He became a machinist's apprentice in the Boston Blower Company, Hyde Park, Mass., immediately after his graduation from Harvard, and was designer and draughtsman for the Dwight Manufacturing Company, Chicopee, Mass., 1896-97, and designer for Arlington Mills, with Harding, Whitman & Co., Boston, 1898-1901. He served in the Massachusetts Naval Militia for one year as a private. He was made a director in The Fisk Rubber Company, Chicopee Falls, Mass.; treasurer and director of the Lowell Weaving Company, of which his father was president from January, 1902, and in 1906 he organized with M. C. Taylor, of New York City, the Le Roy Cotton Mills, of Le Roy, N. Y., with a capital of $450,000, for the purpose of making black and white twist yarns, and in June, 1906, on the first election of the board of directors, he was made treasurer and general manager of the mills.

In 1907, with M. C. Taylor and Chas. M. Warner, of New York City, he bought the Victoria Mills, of Newburyport, Mass., then owned by the Peabody Mfg. Co., converting it from a weaving mill into a yarn mill. The new company was named the Warner Cotton Mills, and organized with a capital of $300,000. He was elected treasurer and general manager at the first meeting, held in January. In 1907, also, he organized, with M. C. Taylor the Boston Yarn Co., with a capital of $2,000, for the purpose of selling the product of the Le Roy Cotton Mills and Warner Cotton Mills, he being elected president. The capital was later increased to $50,000 in 1908, and then to $100,000 in 1909, and the company took on also the selling accounts of the Lowell Weaving Co. and Passaic Cotton Mills, of Passaic, N. J. In April, 1910, the capital stock of the company was sold outright to the J. Spencer Turner Co., of New York City, the management being left in control.

In March, 1909, he organized with M. C. Taylor, of New York City; R. P. Snelling and F. T. Hale, of the Saco-Pettee Co., and C. M. Warner, of New York City, the Bay State Cotton Corporation, capitalized at $1,500,000, which, acting as a holding company through exchange of stock, combined the Lowell Weaving Co., Warner Cotton Mills and Le Roy Cotton Mills. He was elected treasurer and general manager at the first meeting. In July, 1910, in conjunction with Messrs. M. C. Taylor, A. P. Loring, S. P. Warfield, R. P. Snelling, F. T. Hale and C. M. Warner, he helped organize the International Cotton Mills Corporation, capitalized at $20,000,000, which, through exchange of stock, combines the Consolidated Cotton Corporation, J. Spencer Turner Co., Boston Yarn Co. and Bay State Cotton Corporation. He was elected vice-president and manager of the Eastern and Canadian Mills, also member of the executive board of directors.

On April 11, 1898, Mr. Jackson married Anne, daughter of William S. and Mary (Head) Smoot, of Brookline, Mass., and their daughter, Anna Loring Jackson, was born October 5, 1904. A son, Patrick Tracy Jackson, was born November 19, 1906, being the fifth of that name in direct descent.

KIRK BOOTT.

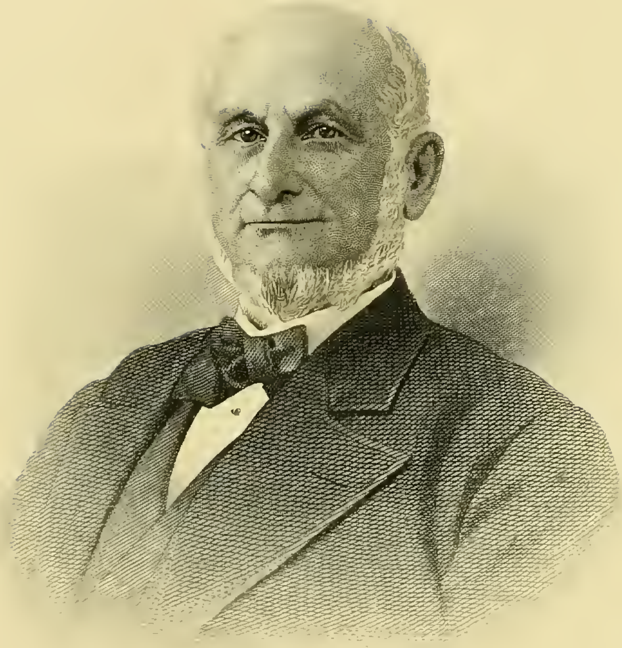
Kirk Boott was born in Boston, Mass., October 20, 1790. He was the son of Kirk Boott, an Englishman who came to Boston soon after the Revolution and established himself as a merchant. He had large shipping interests, Boott & Sons being importers of British goods, for sale almost exclusively to the country trade, and resided in a mansion at the corner of Cambridge Street and Bowdoin Square, then known as the Boott House, and now the Revere House.

The younger Kirk Boott was one of nine children: John Wright, Kirk, Francis, James, William, Frances, Annie, Mary L. and Eliza. He was educated at Rugby, England, entered Harvard in 1807, but did not complete his course. He studied surveying and engineering in England, and his father purchased a commission for him in the English army as Lieutenant in the Eighty-fifth, the Duke of York's regiment, in which capacity he served in the Peninsular War under Wellington. During July, 1813, he commanded a detachment at the siege of San Sebastian. He was present at the battles of Nieve and the Nevelle, the passage of the Garonne, and the siege of Bayonne. In all, he served with great credit for five years in the British army; but his loyalty to his native country caused him to yield his commission when his regiment was ordered to America, where later it participated in the Battle of New Orleans.

Mr. Boott returned to England and married there a lady of high social standing. In 1817 his father's death drew him back to America, where he joined his brothers in carrying on the business in which his father had been highly successful, but which, under the management of the sons, proved a failure.

In 1821 he was urged by Patrick T. Jackson to accept a partnership in the new manufacturing interest at East Chelmsford, Mass., then being fostered by Mr. Jackson and Nathan Appleton. Mr. Boott assented, and the articles of the Merrimac Manufacturing Company being drawn up, he was appointed its treasurer and agent, January 1, 1822, for a period of five years, at a salary of three thousand dollars per annum. He purchased, at a par value of $1,000, ninety out of its six hundred shares of stock.

The act of incorporation was granted February 5, 1822, and Mr. Boott settled with his family at East Chelmsford (afterwards Lowell), where he resided until his death. He had charge of all the operations necessary in the building and equipment of the mill, which included the enlargement of an old canal and the building of a new one before it could be successfully operated. The Merrimac Company's Mill commenced to manufacture printed calicoes September 23, 1823. Mr. Boott was appointed agent of the Company of the "Proprietors of Locks and Canals on Merrimac River" upon its re-organization in 1825, and combined that office with his duties as treasurer and agent of the Merrimac Company, and to his tireless energy



George Draper

and fostering care the cotton industry of America is in no small measure indebted for its immense success in the early days of its establishment. Though Jackson and Appleton had their share in the making of the mill industry in Lowell, yet the foremost of these are Boott and Lowell. When writing of either, their names must be associated as the promoters of Lowell.

Mr. Boott was a man of integrity and honor, and well fitted to take the part of a leader in a great industrial enterprise. He was interested in the political affairs of Lowell, served as its representative in the legislature, and took a deep interest in all matters pertaining to its welfare.

At his death he left a wife and a family of six children: Kirk, John Wright, Fred, Sarah, Mary Love, and Eliza. He died very suddenly, at the age of forty-seven, April 11, 1837.

GEORGE DRAPER.

George Draper was born in Weston, Mass., August 16, 1817. He was the son of Ira and Abigail (daughter of Lemuel and Rebecca Richards) Draper; grandson of Abijah and Alice (Eaton) Draper; great-grandson of James and Abigail (Whiting) Draper, and great-great-grandson of James, the immigrant progenitor of the American Drapers, who was a son of Thomas Draper, a well-known manufacturer and fuller of Yorkshire, England. The son was brought up in his father's business, and in 1647-48 came to Massachusetts with his wife, Miriam Stansfield, and settled at Roxbury. Major Abijah Draper, the grandfather of George (1737-1780), was an officer in the Colonial militia and commanded a body of minute men under Washington at Roxbury, 1776, and took part in the Battle of Lexington. His son, Ira Draper (1764-1848), was the inventor of the first threshing machine, of the "fly shuttle handloom," of the "revolving temple" for keeping cloth extended in the process of weaving, and of many minor inventions; and, during the administration of President John Quincy Adams, he was a candidate for the office of United States Commissioner of Patents.

George Draper, the subject of this sketch, attended the public schools of Saugus and worked on his father's farm. When fifteen years of age he became second-hand of weaving in the cotton mills at North Uxbridge. He then entered the cotton-sheeting mill located at Walpole, Norfolk County, a small manufactory of which he was superintendent and manager for a short time. From the Walpole Mill he went to Three Rivers, Mass., where he was overseer of weaving in a large mill, 1835-39, and while there he made an improvement in the revolving temples invented by his father. He was then employed for three years at the Lowell Mill, after which he was engaged as designer in the mill built by Edward Harris in Woonsocket

for the manufacture of "Harris cassimeres." In 1845 he went to Ware, Mass., as superintendent of one of the Otis Company's Mills, and before he left the employ of the Otis Company he was general superintendent of the entire plant. In 1853 he removed to Hopedale, then a part of the town of Milford, Worcester County, and he there joined his brother, Ebenezer Daggett Draper, in the business organized by his father for the manufacturing of revolving temples. He also became a member of the Hopedale Community, of which his brother, E. D. Draper, was president. This was a socialistic organization intended to be based upon practical Christianity, and was founded by Adin Ballou about the year 1842, on a joint stock basis, with a mutual industrial division of profits. The Community failed in 1856, and Ebenezer D. and George Draper took the property and paid its debts. By this means they became owners of two small shops in which hatchets, temples, shoe boxes, etc., were manufactured, the work being done by fifteen hands, and this was the foundation of the Hopedale inventions and the fortune of the Draper Company. In 1868 Ebenezer D. Draper retired from the business, and this made way for the firm of George Draper & Sons. George Draper was a man of great ability as an inventor, and he took out probably over one hundred patents, including self-acting temples, railway head-eveners, parallel shuttle motion, a new form of let-off motion, a shuttle guard for looms, a self-lubricating bearing for spindles, double adjustable spinning rings, slasher, warpers and bobbin holders for spooling. His high speed and power-saving spindle is said to have doubled the quantity of yarn produced in a given time, and his improvements in speed and power utilization were estimated to represent a saving equal to two water-powers like that of Lowell. His spinning-frame separators came into universal use in the United States and into general use in England. Mr. Draper was a large stockholder in many cotton manufacturing corporations in New England and a large owner in the Shaw Stocking Works, of Lowell, of which concern he became president; the Glasgow Thread Co., of Worcester, and the Glasgow Yarn Mills, of Norwich, Conn. He was also interested in the Milford and Woonsocket and in the Hopkinton railroads. His political faith found expression first in the Whig party, and, upon its dissolution, in the Free-Soil organization, out of which evolved the Republican party in 1855. He was the organizer of the Home Market Club and its first president. He kept in close touch with the leaders in public affairs in Massachusetts in the Republican party, but always refused to accept public office. He favored the abolition movement, was a friend of William Lloyd Garrison, and was a member of Governor John A. Andrew's Advisory Board during the Civil War. During this period his business was always second to his interest in the soldiers at the front and in the general support of the government. After the war his concern was for the protection of the manufacturing industries of the country, and he kept a zealous watch over the lawmakers at Washington and maintained a con-

stant correspondence with Representative William D. Kelly, of Pennsylvania; William McKinley, of Ohio, and George F. Hoar, of Massachusetts, and the other prominent champions of protection in the United States Congress. This interest absorbed most of his time during the later part of his life. His gifts of money included a handsome annual gift to the Soldiers' Home in Chelsea, the Town Hall in Hopedale, while to the Unitarian Church in Hopedale his gifts were liberal and continuous. His private beneficence was generous and unostentatious; he cared for the men in his employ with a father's interest; the temperance cause was one of his most anxious concerns, and the Grand Army Posts were constant debtors to his benevolence. Mr. Draper married, March 6, 1839, Hannah, daughter of Benjamin and Anna Thwing, of Uxbridge, Mass. This union was blessed with eight children, of whom the eldest was William Franklin Draper, *Ibid;* the second son died in infancy; the third son, George Albert, was born in Hopedale, November 4, 1855, and the fourth son, Eben Sumner, was born in Hopedale, June 17, 1858. His two daughters who reached maturity were: Frances E. (Colburn) and Hannah T. (Osgood).

Mr. Draper was a pioneer manufacturer of cotton machinery in New England, and was a man of extraordinary strength of character, energy and intellectual attainment, coupled with great mechanical skill. He was the author of numerous pamphlets relating to protection and to the manufacture of cotton goods. He died at the United States Hotel in Boston, Mass., June 7, 1887.

EBENEZER DAGGETT DRAPER.

Ebenezer Daggett Draper was born in Weston, Middlesex County, Mass., June 13, 1813; son of Ira and Abigal (Richards) Draper; grandson of Major Abijah and Alice (Eaton) Draper and of John and Elizabeth (Lovering) Eaton, of Dedham, and a descendant of James and Miriam (Stansfield) Draper. James Draper, the immigrant, founded a textile business in Roxbury, Massachusetts Bay Colony, in 1647, having learned the trade of fuller of cloth from his father, Thomas Draper, of Yorkshire, England. Ira Draper, the father of Ebenezer Daggett Draper, was the inventor of the first threshing machine and of the revolving loom temple. He conducted a farm in Weston and removed from Weston to Saugus, Mass., where Ebenezer attended the district school and when sixteen years of age found employment in the cotton mills at North Uxbridge, Worcester County, Mass., and subsequently was overseer of the mills. He became president of the Hopedale Community, formed about the year 1842 as a joint stock, practical Christian association with a mutual industrial arrangement by which the capital and profits were communistic. The

Community grew to a village of about fifty dwellings and about two hundred and fifty people. They owned six hundred acres of land and a few small shops; the shop for the manufacture of the Draper revolving temples, used in holding cloth while being woven, being the contribution of Ebenezer Draper, who was joined by his brother, George Draper, in 1852. In 1856, when the Hopedale Community gave up business, the firm of E. D. & G. Draper was formed and they took the property of the Community, paid the debts, and continued the manufacture of revolving temples and loom improvements. Subsequently, Ebenezer Daggett Draper withdrew in 1868 to become treasurer of the American Steam Fire-Proof Safe Company, and in this venture he lost all his property.

The subject of this sketch married Anna Thwing, September 11, 1834. No children were born of this union, but a son, Charles Henry Eaton, was adopted, and he became a prominent Universalist clergyman and died in New York City in 1902. Mr. Draper died October 20 1887.

WILLIAM FRANKLIN DRAPER.

William Franklin Draper was born in Lowell, Mass., April 9, 1842. He was the eldest son of George and Hannah B. (Thwing) Draper. (For genealogy see sketch of his father, George Draper, *Ibid.*) He was brought up in Lowell, Mass., Woonsocket, R. I., Ware, Mass., where he attended the high school, and at Hopedale, Mass., where he was a pupil in the Hopedale Home School. His father, George Draper, being a member of the Hopedale Community, William F. was brought up according to the tenets of the sect, and his study was interspersed by periods of manual labor. He left school at sixteen, in the expectation of entering Harvard when a few years older, and spent the ensuing three years in P. Whitin & Sons Mill in North Uxbridge, in a mill at Wauregan, Conn., and at the Saco Water Power Co., Biddeford, Me., in acquiring a practical knowledge of the details of all the departments of cotton manufacturing. His work in these directions was brought to a close August 9, 1861, by his enlistment in a volunteer company that was being recruited through the inspiration and efforts of his father. The Hopedale Company became the Twenty-fifth Massachusetts Volunteers, young Draper being chosen second lieutenant. His war record was a brilliant one, and is chronicled elsewhere. (See "Recollections of a Varied Career." William F. Draper. Also National Biography, Volume VI). His term of service expired October 12, 1864, and he was honorably discharged, with the brevets of colonel and brigadier-general for "gallant service during the war." General Draper then entered the employ of the firm of E. D. & G. Draper at Hopedale. This firm,

William F. Draper

formed in 1852, was composed of his uncle, Eben D. Draper, and his father, George Draper, who had succeeded their father Ira in 1825, Ira Draper having been in business from 1816 as the inventor and maker of revolving temples and looms. General Draper in 1868 bought out the interest of his uncle, Eben D. Draper, and the firm of George Draper & Son came into existence. In 1887, George A. Draper, the second son of George Draper, was admitted and the firm name became George Draper & Sons, and in 1880, Eben S. Draper, the third son of George Draper, became a partner. In 1887, George Draper, the senior member of the firm, died, and William F. Draper, Jr., the eldest son of General Draper, was admitted to partnership. In 1189, George Otis Draper, the second son of General Draper, was admitted to the firm, and in January, 1897, the business was reorganized and corporated as the Draper Company, with William F. Draper, Sr., as president. His part in the business as senior member of the firm and as an inventor is most noteworthy. His mechanical and inventive talent were an inheritance from two and a half centuries of family skill and growth along the line of textile manipulation applied to the raw woolen and cotton by way of spinning and weaving, but principally applied for the last century to cotton. The Drapers, under the auspices of General Draper, have doubled the speed of spindles and divided the cost of spinning cotton yarns by two. Their inventions not only came into universal use in the United States, but were largely introduced in other parts of the world. To America, the cost of machinery alone has been so decreased by reason of their inventions as to save not less than fifty million dollars to manufacturers, while the saving in labor, power and incidental expenses has probably been four times as great. General Draper, in 1905, hoped to halve the cost of weaving as he had of spinning, and had for many years employed as skilled inventors Mr. James H. Winthrop and Mr. Charles F. Roper, and others, to carry out the results of his own thought and study along the lines of improving the art of weaving. The machine was in 1906 perfected for many lines of cotton goods and he assigned himself the task of perfecting it in all lines. He took charge of the business of defending the patents of himself, which on cotton machinery numbered nearly one hundred, and those of his co-workers, against infringement, and in it showed marked legal instinct. As a mechanic he became known as one of the foremost experts in the United States on spinning machinery. This was largely due to his early training under his father and his long experience as an inventor and manufacturer.

General Draper, in his memoirs under the title of "Recollections of a Varied Career" in the final chapter makes reference to the causes which led to a most important change in his business relations, occurring in 1906. At the time of General Draper's death, he was busily engaged in experiments carried on under his own personal supervision to still further improve the art of weaving.

For thirty-five years General Draper was a director in the Milford National Bank, was one of the heaviest stockholders in the Milford Shoe Co., Milford Water Co., Milford Gas Light Co., and other Milford enterprises, in most of which he was a director.

He was a director of the Arlington and other cotton mills, and also a director of the First National Bank of Boston.

General Draper was a member of the school committee of Hopedale, member of Governor Long's staff during his three years' service to the Commonwealth, 1880-83, was a delegate to the Republican National Convention of 1876, elector-at-large for Massachusetts on the Harrison and Morton ticket in 1888; was a candidate before the Republican State Convention, in 1888, for the nomination of his party for governor of Mass., and received a handsome vote in the convention, and in 1889, he declined an assured nomination for that office, he represented the eleventh district of Massachusetts, in the fifty-third and fifty-fourth Congresses, 1892-07, where he was a bulwark of defense against the enemies to protection, second on the committee on foreign affairs and acting chairman during a continued illness of Representative Hitt, of Illinois, the chairman of the committee. He also held the chairmanship of the Committee on Patents. He urged moderate action on the Chinese exclusion bill and his speech on the Hawiian question was adopted as a part of the Senate report. He opposed the resolution which censured Ambassador Bayard and his speech was widely published and received the hearty commendation of the conservatives of both political parties. He served as United States Ambassador to Italy, 1897-1900, by appointment of President McKinley, and in 1900, he was decorated by King Victor Emmanuel III with the Grand Cordon of the Order of S. S. Maurice and Lagare, and he received the honorary degree of LL. D. from Washington and Lee University in the same year.

He was a companion of the military order of the Loyal Legion of the United States, and he served as commander of the Massachusetts division of the order. He was a member of the Arkwright Club, Grand Army, Knights Templar, Sons of the Revolution, Society of Colonial Wars, the Union and Algonquin Clubs, and the Hope Club of Providence.

General Draper married, September 15, 1862, Lydia, adopted daughter of the Hon. David Joy, of Nantucket, Mass., and the children by this marriage were William Franklin, Jr., George Otis, Edith, Arthur Joy and Clare H. Mrs. Draper died February 14, 1884. Mr. Draper married secondly, May 22, 1890, Susan Christy, daughter of General William Preston, of Kentucky, an officer in the Mexican War, United States Minister to Spain under Buchanan and a major-general in the Confederate army. By the second marriage one child, Margaret Preston, was born, March 18, 1891.

General Draper was the author of "History of Spindles" (18—); "Influence of Invention on Cotton Manufacturing Industries" (18—); an

autobiography entitled "Recollections of a Varied Career," 1908; and of numerous magazine articles.

General William F. Draper died at his home in Washington, D. C., January 31, 1910.

EBEN SUMNER DRAPER.

Eben Sumner Draper was born in the town of Milford (that part of the town called Hopedale), Worcester County, Massachusetts, June 17, 1858, son of George and Hannah (Thwing) Draper. (For ancestry see sketch of his father, *Ibid.*)

The subject of this sketch attended the public schools of his native town, and was prepared for business life in the Allen School, West Newton, Mass. He then completed a course in the deparatment of engineering at the Massachusetts Institute of Technology, in 1880, and began work in the Hopedale Machine Shops, where he was thoroughly trained in the various details of the intricate business. He had at first obtained a practical knowledge of the working of cotton machinery in the cotton mills of Lowell, Manchester and other New England manufacturing cities, and his knowledge thus acquired, through three years of practical work, made him expert and at home either in the cotton mill, where it was to be his business, as selling agent for the Hopedale concerns, to introduce new machinery, or in the machine shop in which the machinery was made.

He was made a member of the firm of George Draper & Sons in 1880. On the organization of the Draper Company in 1896, he was elected selling agent.

Mr. Draper became a member of the corporation of the Massachusetts Institute of Technology and of the Board of Managers of the Milford Hospital, which he and Mrs. Draper presented to the town of Milford and which is one of the best equipped hospitals in the State. Also a member of the Board of Trustees of the Peter Brigham Hospital, and vice-President of the American Unitarian Association. He was also a director of the Boston & Albany R. R., National Shawmut Bank, Old Colony Trust Co., and New England Cotton Yarn Co. He was associated with the Hopedale Machine Company, the Dutcher Temple Company, the Hopedale Screw Machine Company, the Globe Yarn Mills, the Continental Mills, of Lewiston and the Glasgow Thread Company. He became vice-President of the Manville Company, and director of the Draper Company, of the Milford National Bank, the Queen City Cotton Company, of Vermont and the Sawyer Spindle Company, of Maine.

Governor Draper was a member of the Massachusetts militia for three years, and on the outbreak of the Spanish-American War, he was made

President of the Massachusetts Volunteer Aid Association by Governor Wolcott, the greatest work of the association being the purchase and equipment of the hospital ship "Bay State," at an expense of $200,000, the association also raising $200,000 more for the care of the Massachusetts soldiers and sailors. He was also chairman of the Massachusetts Association for the Relief of California.

Governor Draper had never held political office or been a political candidate up to 1905, when the Republican State Convention unaminously nominated him for Lieutenant Governor of the Commonwealth, and he was elected and inaugurated January, 1906, under Governor Guild. He had, however, served his party as a member of the Milford Republican Town Committee, and of the Hopedale Town Committee. He was also chairman of his Senatorial district committee, and was a member of the Congressional district committee. He also served as chairman of the Republican State Committee in 1892, and declined a unanimous re-election in 1893, but served as a member of the committee for the three years following. He was president of the Massachusetts Republican Club for two years, and a member of the Club from its organization. The subject of this sketch was re-elected lieutenant-governor for 1907 and 1908, and served as governor in 1909 and 1910. In 1911, he again became candidate for the same office, but was defeated by Eugene N. Haas.

He served as a delegate from Massachusetts in the Republican National Convention at St. Louis in 1896, and was made chairman of the Massachusetts delegation. He, of all the delegates to that convention, made the canvass on the question of making the platform decidedly for gold as the unit of monetary measure, and through fifty sub-committees working under his direction he secured a report that showed the standing of every delegate in the convention on that important subject.

In 1900 he was Republican Elector for the eleventh Congressional District of Massachusetts; chairman of the Massachusetts delegation to the Nashville Exposition in 1897; served three years as lieutenant-Governor, and is now serving his second year as Governor.

Mr. Draper was also a member of the Society of Colonial Wars, Republican Club of Massachusetts, Society of the Sons of the Revolution, Middlesex Club, Norfolk Club, Massachusetts Club, Somerset Club, Union Club, New Algonquin Club, Exchange Club, Country Club, Home Market Club, Hope Club (Providence), Metropolitan Club (New York), etc.

Mr. Draper married November 21, 1883, Nannie Bristow, daughter of the late General Benjamin Helm Bristow, of New York, who was Secretary of the Treasury, under Grant, and candidate for the Presidency in 1876. They had three children, Benjamin Helm Bristow, born February 28, 1885; Dorothy, born November 22, 1890; Eben S., Jr., born August 30, 1893.

George Otis Draper

GEORGE ALBERT DRAPER.

George Albert Draper was born in Hopedale, Worcester County, Massachusetts, November 4, 1855, the second son of George and Hannah (Thwing) Draper. He received his primary and secondary education in his native town, and after a two years' course in mechanical engineering at the Massachusetts Institute of Technology, Boston, he entered the employ of the firm of Geo. Draper & Son, and in 1877 was admitted a member of the firm. He subsequently served as treasurer of the Hopedale Machine Company.

In January, 1897, when the business of George Draper & Sons and others was incorporated as the Draper Company, he was elected treasurer of the corporation, which position he has continued to hold up to the present time.

He married, November 6, 1890, Jessie, daughter of General William Preston, of Kentucky.

GEORGE OTIS DRAPER.

George Otis Draper, second son of General William F. Draper, was born in Hopedale, Mass., July 14, 1867. His mother was Lila Warren Joy, adopted daughter of the Hon. David Joy, of Nantucket, Mass., married Captain William Franklin Draper, U. S. V., in September, 1862, when the young captain was on leave of absence for four days by reason of promotion from the twenty-fifth to the thirty-sixth Massachusetts volunteers. (For ancestry see sketch of George Draper, *Ibid.*) George Otis Draper was as a boy interested in mechanical drawing and was fond of working in the shops of his father when not attending school. He was a pupil in the celebrated English and Classical School conducted by the Allen brothers, at West Newton, Mass., and he went from this school to the Massachusetts Institute of Technology where he was graduated in 1887, having taken a mechanical engineering course. He then became a machinist in the Hopedale Works, and there learned the practical details of the business. He was admitted a partner in the firm of George Draper & Sons on January 1, 1889. He became an inventor as well as manufacturer of cotton machinery and this adaptability to the wants of the business grew out of personal application and private reflection. He invented over one hundred devices which he patented, many of which were put into practical use in his business, especially those applying to the perfection of the Northrop looms. He served the town of Hopedale as Assessor from 1894, and was made a member of the Hopedale Park Commission. He became a stockholder and officer in at least a score of corporations organized to further the advance-

ment of textile manufacturing, mining, quarrying and the development of patented inventions, giving to each much of his time and thought. This work was in addition to his duties as secretary of the Draper Company, the largest American builders of cotton machinery. He was elected to membership in the Home Market Club, of Boston, organized by his grandfather and of which his father was president for two years. He was also a member of the Republican Club of Massachusetts, the New England Cotton Manufacturers' Association, the American Inventors' Association, the Society for Psychical Research; the Algonquin, Puritan Athletic and Automobile Clubs of Boston; the Country Club of Brookline, Mass., the Metropolitan Club, of Washington, D. C.; the Technology Club, of Boston, and Theti XI Graduate Club, of New York. He joined the fraternal association of Knights of Pythias, founded in Washington, D. C., February 9, 1864.

On April 28, 1892, Mr. Draper married Lilly, daughter of Henry and Lily (Braid) Duncan, of Lexington, Ky., and had three children, Elise Allen Draper, George Otis Draper, Jr., and Henry Duncan Draper. The marriage was annulled by divorce obtained in July, 1903. Mr. Draper was the author of various technical pamphlets, including Facts and Figures (1898); Textile Texts (1891); Labor-saving Looms (1904); Searching for Truth (1902) and Still on the Search (1904), the latter work being illustrated by drawings from his own pencil, the two volumes being intended to give his theories on various theological doctrines, he being greatly interested in liberal theology. He travelled extensively for recreation and information, and entered into many automobile contests, winning several prizes and trophies. He was a liberal contributor to the various philanthropic institutions and charities of Massachusetts, irrespective of denominational control. Mr. Draper served two terms as vice-president of the National Association of Cotton Manufacturers, was a member of the Board of Government of the American Civic Association, and the Welfare Committee of the National Civic Federation.

In 1907, a change of policy was adopted by a majority of the Draper Company directors, which ultimately led to the resignation of General Draper and his two sons. George Otis Draper decided to make New York City his future home, and being adverse to anything in the nature of a competition with his former associates, he entered into other lines of industry, still giving liberal time to the development and introduction of patented improvements. In 1908, he published a work on political economy, which obtained very universal commendation from art critics.

WARREN WHITNEY DUTCHER.

Warren Whitney Dutcher was born in Shaftsbury, Vermont, July 4, 1812, son of Peter and Lucy (Slye) Dutcher. His ancestors were among the early Dutch settlers of Eastern New York. Warren Whitney Dutcher obtained his education in the local district school during the few months in each year that it was in session. At the age of thirteen he was employed as bobbin boy in a small woolen mill in Shaftsbury. After several years' experience in the woolen mill, at the age of nineteen, he obtained a position in a cotton mill at North Bennington, Vermont. Later on he had charge of the weaving in the Doty mill in that place. In 1846 he patented the parallel shuttle motion, the first successful attempt in this direction. He also made various improvements on speeders and other machines.

In 1851 and 1852, in connection with his older brother, Elihu C. Dutcher, he obtained patents on reciprocating loom temples using toothed cylindrical rolls, and began their manufacture in North Bennington under the firm name of E. & W. W. Dutcher. The great improvement made in weaving by these temples attracted the attention of the Drapers, and in 1854 they purchased the interest of Elihu Dutcher in the patents and business, and the partnership of W. W. Dutcher & Co. was formed to manufacture the temples, E. D. & G. Draper acting as selling agents. In May, 1856, this industry was transferred to Hopedale, Mass. In 1867, the Dutcher Temple Company was incorporated, with Warren W. Dutcher as agent, and he continued in this position until his death. During this period he made and patented many improvements in loom temples; he also designed ingenious and accurate machines for use in their manufacture, many of which are still in everyday use.

Recognizing the importance of good castings, Mr. Dutcher made it one of the conditions of his removal to Hopedale that a foundry should be built and castings made on the premises. The Hopedale Furnace Company carried on a separate business in this line as a co-partnership, of which Mr. Dutcher was a member, until 1867, when it was incorporated as a stock company. From the time he began the construction of loom temples he had entire charge of their manufacture up to the time of his last illness, and the high quality of work produced bore evidence to the thoroughness of his supervision.

Mr. Dutcher married, October 10, 1841, Malinda Amelia, daughter of Lyman and Eleanor (Stearns) Tombs, of Hoosick, N. Y. Their children were Charles Volney, born July 23, 1848, died October 25, 1848; Frank Jerome, born July 21, 1850; and Grace Mary, born July 17, 1853. Mr. Dutcher died at Hopedale, January 26, 1880, and his wife died February 9, 1888.

FRANK JEROME DUTCHER.

Dutcher, Frank Jerome, was born at North Bennington, Vermont, July 21, 1850, the son of Warren Whitney and Malinda Amelia (Tombs) Dutcher. He received his education in the public schools of Hopedale and Milford, and was graduated from the Milford High School in 1868. In September of that year he was engaged as office boy by the newly organized firm of George Draper & Son. For many years, until 1896, when it merged with the other Hopedale Companies, he served as treasurer of the Dutcher Temple Company. He also became agent of the Hopedale Furnace Company and treasurer of the Hopedale Machine Screw Company. On the formation of the Draper Company, Mr. Dutcher was chosen assistant agent; in 1907 vice-president, and in 1909 president, which position he still holds.

Mr. Dutcher married, January 27, 1877, Martha Maria Grimwood, of Pawtucket, R. I. Their children were Warren Whitney, born August 29, 1880; Daisy Grimwood, born November 28, 1881; and Ruth Collyer, born April 21, 1887.

JOSEPH BUBIER BANCROFT.

Joseph Bubier Bancroft, one of ten children of Samuel and Mary (Bubier) Bancroft, was born at Uxbridge, Massachusetts, October 3, 1821, his father being a native of Marblehead, who during the War of 1812 was taken prisoner by the British and confined in the infamous Dartmouth prison.

His educational opportunities were limited to the primitive schools of the district system. At an early age he went to work in one of the mills in the neighborhood, but preferring mechanical pursuits, served an apprenticeship at the machinist's trade. He was employed in Woonsocket, R. I., Medway, Uxbridge, and elsewhere, for various lengths of time, and in 1847 joined the Hopedale Community at Hopedale, Mass. When the Community gave up its business interests, Mr. Bancroft associated himself with Ebenezer D. and George Draper, his brothers-in-law, under the firm name of Hopedale Machine Company, to manufacture various improvements in cotton machinery, Mr. Bancroft having charge of the works. After the incorporation of the company in 1867, he was made superintendent, which position he held for many years.

In 1896, the business was incorporated as the Draper Company, and Mr. Bancroft was elected vice-president, officiating continuously as such until July, 1907, when, upon the retirement of General Draper, the subject of this sketch became president.

Mr. Bancroft was an unassuming man of quiet tastes and confined most of his attention to business interests. He never sought public office,

although in 1877-78-79 he served as selectman and represented the town of Milford in the Legislature in 1864. In 1875, Mr. Bancroft became and remained until 1881 an engineer of the Fire Department. He rendered service on the directorate of the Home National Bank of Milford for ten years, and was associated with the management of the Milford Gas Light Company, as president, which position he resigned May 26, 1909, on account of his failing health. In all official connections Mr. Bancroft was held in the highest esteem, for his ability as well as his trustworthiness. A member of Montgomery Lodge, A. F. and A. M. of Milford, Mt. Lebanon R. A. Chapter, and Milford Commandry, he was in all these orders, on account of special favors rendered, voted an honorary life member.

Though extremely unostentatious in his giving, Mr. Bancroft was very charitable, and during his life benefited many in the community where he lived. Coming from the ranks of the laboring class, he appreciated the needs and trials of the ordinary workman, and his liberality to such was unbounded. To him also the town of Hopedale is indebted for its magnificent granite library building, which was erected to his wife's memory in 1898, he having married in 1844 Sylvia Willard, daughter of Benjamin and Anna (Mowry) Thwing, of Uxbridge. Ten children were born to Mr. and Mrs. Bancroft, five of whom at this writing are still alive, viz., Eben D., vice-president and purchasing agent of the Draper Company; Anna M., unmarried; Gertrude, wife of Walter P. Winsor, of Fairhaven, Mass., president of the First National Bank of New Bedford; Lilla J., wife of H. W. Bracken, of Hopedale, one of the Draper Co. superintendents; and Lura B., widow of Charles M. Day, who at the time of his decease was general superintendent of the Draper Company. Mrs. Bancroft died in 1898.

At the advanced age of eighty-eight years, Mr. Bancroft died October 25, 1909.

EBEN DRAPER BANCROFT.

Eben D. Bancroft, son of Joseph Bubier and Sylvia W. (Thwing) Bancroft, was born in Hopedale, Mass., August 27, 1847. He was educated in the public schools of Milford and in a private school at Providence, R. I. In 1866 he was engaged by his uncles, E. D. and G. Draper, to take charge of their office and accounts. In 1868 he succeeded to the same position with George Draper & Son and had continuous charge of this branch of the business during the various changes The office force during this period has increased from three persons to nearly one hundred. Mr. Bancroft served as a director in the Hopedale Machine Company, and when the Draper Com-

pany was organized he was chosen purchasing agent. In 1909 he was elected vice-president.

Mr. Bancroft married, September 9, 1874, Lelia Coburn, daughter of Alonzo and Eliza Curtiss (Jones) Coburn. Their children were Alice Coburn, born July 3, 1876, and Joseph Bubier, born February 26, 1880, who was graduated from Harvard University in the class of 1903, and became assistant treasurer of the Portland Iron & Steel Company, rolling mill at Portland, Maine.

PAUL WHITING OR WHITIN.

Paul Whiting or Whitin was a descendant in the fifth generation of Nathaniel Whiting, who came from Norfolk County, England, to Lynn (then Saugus) Massachusetts Bay Colony, about 1635, and after ten years' residence in Lynn he removed to Dedham where he married Hannah, only daughter of John Dwight, who with his wife Hannah immigrated to Dedham, Massachusetts Bay Colony, from England in 1634. Nathaniel's great-grandson, Nathaniel Whiting, lived on the boundary line between Dedham and Roxbury, and married Sarah Draper. Here their son, Paul Whiting, was born December 3, 1767. In 1769 Nathaniel Whiting died and his widow married, in 1770, James Prentice, a farmer of Baylies Hill, Uxbridge, and in 1776 they removed to Sutton, where Paul was brought up on his stepfather's farm and attended school. He worked on the farm. At the age of fourteen he began to learn the trade of blacksmith at Northbridge, and served an apprenticeship of nearly seven years with Jesse White. He then worked for four years as a journeyman blacksmith. December 3, 1793, he married Betsey, daughter of Colonel James Fletcher, who had married a daughter of Ezra Wood of Upton, who had in 1771 purchased a farm and iron-producing furnace and forge on the Mumford River in Northbridge. They produced iron from the ore. Paul Whiting worked in his father-in-law's saw-and-grist mill for one year after his marriage. He then worked at his trade as a blacksmith for one year, when he bought out the business and conducted it on his own account. He soon after operated a small forge owned by Colonel Fletcher on the south side of the Mumford River, the drop-hammer being operated by water-power. About this time he was town clerk, and in signing his name dropped the final "g." He continued to serve as town clerk for thirteen successive years. On the privilege, which afterwards supplied power to the Whitin Machine Works, he built in 1809 a cotton mill operated by the Northbridge Manufacturing Company, of which he was the principal stockholder. This was the third cotton mill erected in the Blackstone Valley above Pawtucket, the mill of Almy, Brown and Slaters having been built in 1807 at

Slaterville, R. I., and the first mill at South Meadow, Mass., operated by the Blackstone Company in 1808. The original mill erected by Paul Whitin was built of wood and was equipped with fifteen hundred spindles. Previous to and after building this mill, Paul Whitin was engaged largely in the making of heavy hoes used by Negro slaves on Southern plantations, and this trade was largely increased by the embargo caused by the suspension of commerce with England during the War of 1812. The Northbridge mill was sold in 1824, and meantime in 1815 Mr. Whitin had entered into a partnership with Colonel Fletcher and his two sons, under the firm name of Whitin and Fletchers, and erected a second cotton mill of three hundred spindles on the site of the old forge for the manufacture of yarns, and the business of this mill was continued until 1826, when Mr. Whitin, who owned a half interest, purchased the other half from the Fletchers and formed a partnership with his sons, Paul Whitin, Jr., and John C. Whitin, under the style of P. Whitin & Sons, and they erected a new mill of fifteen hundred spindles on the site of the mill of three hundred spindles. Paul Whitin, Sr., invested the capital, but took no part in the management of those mills.

Paul and Betsey (Fletcher) Whitin had ten children, of whom eight lived to maturity, and five, Paul, Jr., John C., Charles P., James F. and Margaret F. (Whitin) Abbot, survived their mother, who had been a widow for thirty-seven years, and for thirty-four years had been a member of the firm of P. Whitin & Sons. She died July 2, 1868.

Paul Whitin died at his home in Northbridge, February 8, 1831, in his sixty-fourth year.

PAUL WHITIN, JR.

Paul Whitin, Jr., was born in Northbridge, Worcester County, Mass., February 5, 1800; son of Colonel Paul and Betsey (Fletcher) Whitin. (See sketch of his father, *Ibid.*) His school attendance was limited to the few months each year of the district school term, a short term at a school in Amsterdam, N. Y., and two terms at the Leicester Academy. From his tenth year, when not at school, he worked in the mill and on the farm of his father, and when eighteen he went to Boston as clerk in the drygoods store of James Beaver, where he remained up to February, 1821, when, with a fellow-clerk named Lee, he removed to New York City and opened the drygoods store of Lee & Whitin on Maiden Lane, then a dry goods centre. In 1826 he returned to Northbridge, Mass., and with his father and younger brother, John C. Whitin, formed the firm of P. Whitin & Sons, cotton manufacturers. He, by reason of his mercantile

experience, took charge of the store and purchase of supplies for the cotton mill and the selling of the yarn and cloth produced. His father died in 1831, and on the reconstruction of the firm, when his mother became a partner, he continued to hold the same position in charge of the mercantile department, and this service covered a period of thirty-eight years. On the dissolution of the firm in 1864, and the division of the property, he received the cotton mill at Rockdale and the mill privileges at Riverdale, where a cotton mill was built from the assets of the old firm, and in 1780 he became president of the newly incorporated Paul Whitin Manufacturing Company, formerly the Rockdale Mill. He held various town offices and took a working interest in public affairs. He was made a trustee for numerous estates, and his fidelity as trustee was as unimpeachable as his conduct of his own personal affairs.

Mr. Whitin married, August 22, 1822, Sarah R. Chapin, of Uxbridge. His son, Charles E. Whitin, continued the business of his father after his sudden death; another son, Henry E. Whitin, was for many years a cotton merchant in New York City. His daughter, Sarah, married Mr. Orvis, of Manchester, Vt., and his daughter, Anna L., in 1910 was still unmarried. He died at his home, February 7, 1884.

JOHN CRANE WHITIN.

John Crane Whitin, fourth son of Colonel Paul and Betsey (Fletcher) Whitin, was born in Northbridge, Worcester County, Mass., March 1, 1807. He attended the public schools of his native town until twelve years old, working between the summer and winter terms of schools in the picker-room of the Northbridge Manufacturing Co. owned by his father. When twelve years of age he was placed in the repair-room of the mill, where he worked three years, and this experience was an apprenticeship to the business in which he achieved his success as proprietor of the Whitin Machine Works. From 1822 to 1825 he was employed in the drygoods store of his brother, Paul Whitin, Jr., in New York City. He returned to Northbridge in 1825, when a partnership was formed between his father, his brother, Paul Whitin, Jr., and himself, as manufacturers of cotton yarns and cloth under the firm name of P. Whitin & Sons. They erected a new mill on the old Whitin & Fletcher mill site. Paul Whitin, Jr., being in charge of the financial and mercantile department, and John C. Whitin of the manufacturing and mechanical department.

In an ell attached to the cotton mill the machine shop was located, and in this room the necessary repairs to the machinery were made. Mr.

John C. Whitin

Whitin doing the work with the aid of one assistant. This department gave birth to the Whitin Machine Works. He had been early brought to a knowledge of the inadequate construction of the machines in use in the cotton mill, and the constant need of repairs, and he directed his leisure time to the improvements needed. In fact, when a boy in the picker-room, he had discovered the defects in the "scutcher" when applied to cotton, long baled and necessarily matted, and his first invention, patented in 1832, was to overcome this difficulty. While working on this invention, Colonel Paul Whitin died and the business was reorganized, his widow and three of the sons, Paul, John C. and Charles P., becoming equal partners. The old firm name, P. Whitin & Sons, was retained and the old Northbridge Mill was repurchased and put into operation. The patented picker and lappers perfected by John C. Whitin attracted the attention of other manufacturers. The firm began to make machines for sale, and the small room, 20x40 feet, in which this work was done, became the nucleus of the Whitin Machine Works. At first the machinery was crude and incapable of producing such accurate and finished workmanship as the works subsequently turned out, but they were the best the market afforded, and met with a ready sale. The successive machines displayed more complete workmanship. For many years the Whitin Works turned out most of the pickers and lappers used in the United States, and Mr. Whitin was encouraged to apply his inventive genius to other cotton mill machinery in the same line, and it soon embraced cards, card grinders, doublers, railway heads, drawing frames, ring frames, spoolers, warpers, dressers and looms, the works finally producing all the machinery used in a cotton mill except fly-frames and mules. In 1847 a large brick shop was built, 102x306 feet, as a machine shop. In 1860 Mr. Whitin purchased the Holyoke Machine Works on his own account. This establishment had been engaged in the manufacture of turbine wheels and of cotton and miscellaneous machinery, and Mr. Whitin made the business profitable. Owing to the distance of Holyoke from Whitinsville, his home, he decided, in 1864, to dispose of it and remove such machinery as he needed to the Whitinsville works, and the Hadley Company purchased the property and transformed it into a manufactory for the production of cotton thread and yarn. The joint business of P. Whitin & Sons as manufacturers of cotton goods and of cotton machinery was divided in 1864. The cotton manufactory had in forty years increased from 1,500 spindles to a capacity of 50,000 spindles. They had added, in 1840, the old Uxbridge cotton mill erected by Robert Rogerson, of Boston, and subsequently they built the Rockdale Cloth Mill in Northbridge, and, in 1845, erected the large stone mill at Whitinsville. In the division of the business in 1864, the three brothers, Paul, Charles P. and James F. Whitin, became owners of the cotton mills, and John C. Whitin, the sole proprietor of the machine works. He enlarged the works by a large brick building with an ell, and in 1865

built a new foundry 100x120 feet on the site of the old Northbridge factory. The increased demands for cotton machinery were met by continued enlargement of the plants in both buildings, and by change in the character of the equipment of tools and machinery. The working force of two men, who were the sole makers of the first machines, had been increased to over seven hundred men, and the improved machine tools introduced had increased the product of each man, making it equal to that of three men using the old-time tools. In 1870 the business of John C. Whitin was organized as a joint-stock corporation under the name of the Whitin Machine Works, with a capital of $600,000. John C. Whitin was elected president; Josiah Lasell, treasurer and general manager; and Gustavus E. Taft, superintendent.

Mr. Whitin filled various offices of trust, being director of the National Bank of Whitinsville, president of the Whitinsville Savings Bank and director of the Providence and Worcester Railroad. He also served as presidential elector in 1876, elected on the Hayes and Wheeler ticket.

Mr. Whitin married, May 30, 1831, Catherine H. Leland, of Sutton, Mass., granddaughter of Silence Dwight, who was a great-granddaughter of John and Hannah Dwight, the Dedham immigrants, 1634, who were thus the common ancestors of both Mr. and Mrs. Whitin. Their only son who attained to manhood, John Maltby Whitman, was employed in his father's works and died October 22, 1872. Their daughter Jane became the wife of Josiah Lasell (*Ibid.*). Mrs. Whitin died Jan. 31, 1873, and Mr. Whitin married Jan. 20, 1875, Sarah Elizabeth Pratt, of Hopkinton. Their only son, John C. Whitin, died in infancy.

John Crane Whitin died at his home in Whitinsville, Mass., April 22, 1882.

CHARLES PINCKNEY WHITIN.

Charles Pinckney Whitin was born in Northbridge, Worcester County, Mass., Aug. 6, 1809; the fifth son of Colonel Paul and Betsey (Fletcher) Whitin. (See sketch of his father, *Ibid.*) His education was received in the schools of the town and in the academy at Leicester. It was such that, when but sixteen, he taught school acceptably in the stone schoolhouse, near Plummers' Corner. He early worked in the cotton mill in which his father was interested, and here learned the rudiments of the art of cotton manufacture, in which he afterwards became so proficient. He continued with his father and brothers until his twenty-first year, when he went to Willimantic, Conn., to fit up and take charge of a cotton mill. Having been called home the next year by his father's sickness,

he remained in his native town, and became identified with and most active in its growth and prosperity. The same year, 1831, after his father's death, he became an active member of the firm of P. Whitin & Sons, in which he had charge of the cotton manufacturing department, and in this he became an expert and an authority. He superintended the erection of the stone mill in Whitinsville in 1845, the enlargement of the North Uxbridge Mill in 1847-8 and the erection of the mill in Rockdale in 1856-7. He was largely interested in the improvement of the water power of the Mumford River, devising and building the dams and reservoirs by which the surplus water of the spring was stored for later use. Whenever his brother, John C. Whitin, who had charge of the machine shop, was absent, this care devolved upon him, and he had practical management of the shop from April, 1860, to January, 1864, while his brother was engaged at Holyoke. When the firm of P. Whitin & Sons was dissolved, Jan. 1, 1864, Mr. Whitin took the cotton mills in Whitinsville and East Douglas and carried on the business of cotton manufacture, having associated his two older sons, Edward and William H., with him. In 1865, with his brother, James F., Whitin, he built the mill in Linwood, and in 1881 he purchased the cotton mill in Saundersville, Mass. At the time of his decease he was a director of the Douglas Axe Company and president of the Whitinsville National and Savings Banks.

Mr. Whitin was selectman of his town in 1852, and served as representative of his district in the General Court in 1859. He was affiliated with the Congregational Church for sixty-five years, and was deeply and intelligently interested in the great missionary and benevolent enterprises of his day to which he was a continuous and liberal contributor.

Mr. Whitin married Sarah J. Halliday Oct. 21, 1834, and she survived him with four sons, three of whom, Edward, William H. and Arthur F., were associated with him in the business, which they continued after his death until June 4, 1893, when William H. died, after which it was continued by the two remaining partners, Edward and Arthur F. His son, Lewis F., was a commission merchant in New York. His only daughter, Helen L., married George L. Gibbs, and died May 9, 1885.

Mr. Whitin died at Northbridge, Mass., Aug. 29, 1887.

JAMES FLETCHER WHITIN.

James Fletcher Whitin was born in Northbridge, Mass., December 21, 1814; the youngest son of Colonel Paul and Betsey (Fletcher) Whitin. (See sketch of his father, *Ibid.*) He was educated in the public schools of Northbridge, and the academies of Uxbridge, Leicester, Munson and

Amherst. He began his active business life in the counting-room of P. Whitin & Sons; he was admitted as a member of the firm in 1847, and assumed entire charge of the financial department, retaining it up to the time of the dissolution of the firm, January 1, 1864. In the division of the property, he received the cotton mill at North Uxbridge, and in 1866, with his brother, Charles Pinckney Whitin, he built the cotton mill at Linwood, known as the "Linwood Mill." When the Whitins obtained control of the Uxbridge cotton mill, May 8, 1849, he was made clerk of the corporation; at the meeting held May 10, 1864, he was elected treasurer and clerk; and at the meeting held May 9, 1899, he was elected president, treasurer and clerk.

Mr. Whitin married, July 23, 1842, Patience H., daughter of Ebenezer and Deborah (Fisher) Saunders, of Grafton. Their son, George M. Whitin, became a director and superintendent of the Uxbridge Cotton Mills May 9, 1878, and died suddenly January 24, 1883. Another son, Albert H. Whitin, became a director of the Uxbridge Cotton Mills in 1887. James Fletcher Whitin died at his home in Northbridge, Mass., March 2, 1902.

CHARLES E. WHITIN.

Charles E. Whitin was born in Uxbridge, Mass., Sept. 13, 1823; son of Paul, Jr., and Sarah (Chapin) Whitin, grandson of Colonel Paul and Betsey (Fletcher) Whitin. Charles E. Whitin was a pupil in the public schools and the academy at Uxbridge, subsequent to which he learned the business of manufacturing cotton in the Whitinsville Cotton Mill, and was not there long before he was advanced to the position of overseer of the carding-room. When P. Whitin & Sons purchased the cotton mill property at North Uxbridge, Charles Whitin was made superintendent of the mill, and when the firm of P. Whitin & Sons was dissolved, Jan. 1, 1864, he transferred his services to the Paul Whitin Manufacturing Company, then known as the Rockdale Mill, and, on its incorporation in 1870, he was made treasurer of the Paul Whitin Manufacturing Company; on the death of his father, Feb. 7, 1884, he succeeded as president of the corporation, and held the office up to the time of his death.

Mr. Whitin held important town, county and state offices, including those of selectman, justice of the peace, and state senator. He was also a director of the Whitinsville National Bank, and a trustee of the Whitinsville Savings Bank.

He married Adeline C., daughter of Oliver C. and Eliza (Jenkins) Swift, of Falmouth, Mass., and of their children three survived their father: Henry Thomas Whitin (*Ibid.*), treasurer of the Paul Whitin

Manufacturing Company; G. Marston Whitin, treasurer of the Whitin Machine Works and president of the Paul Whitin Manufacturing Company, and Eliza Swift, wife of Paul Whitin Abbott, of Boston. Charles E. Whitin died in Whitinsville, Mass., Feb. 8, 1890.

WILLIAM HALLIDAY WHITIN.

William Halliday Whitin was born in Whitinsville, Mass., Sept. 5, 1841, the second son of Charles Pinckney and Sarah (Halliday) Whitin, grandson of Colonel Paul and Betsey (Fletcher) Whitin.

William H. Whitin attended the public schools of Northbridge, was prepared for college at Easthampton, Mass., and was graduated from Yale College, A. B., 1863. He spent two years in post-graduate studies at home and one in travel in Europe, and on his return to Massachusetts he determined to take up the business of his father, that of a cotton manufacturer. He spent two years in the careful study of the economy of production, the question of machinery and of the wages and the waste and natural losses in conducting the business under prevalent methods. In 1868 he assumed the superintendence of the Whitinsville Cotton Mills, and conducted the business for twenty-five years with profit and to the entire satisfaction of the other stockholders, and also of the employees. He was interested as a stockholder and director in the Saunders Cotton Mill, Saundersville, Mass., of which he was president at the time of his death, and in the Linwood Mill, at Northbridge, erected by his father, Charles P., and his uncle, James F., and conducted by his father, his brother Edward and himself. He was also a director of the Whitinsville National Bank, and a trustee of the Whitinsville Savings Bank. He served his native town as a member of the school committee for twenty-nine years, and as selectman for several years, being chairman of the board for four years. He was a member of the board of directors of the New England Cotton Manufacturers' Association, and as he always attended the annual meetings, by his advice and council he secured the esteem and confidence of his fellow-manufacturers of New England.

He died at his home in Whitinsville, Mass., June 4, 1893.

HENRY THOMAS WHITIN.

Henry Thomas Whitin was born in North Uxbridge, Mass., Dec. 15, 1854; son of Charles E. and Adeline (Swift) Whitin, grandson of Paul Whitin, Jr., Charles E. Whitin, son of Paul, Jr., and Sarah (Chapin) Whitin, and was married, Oct. 12, 1853, to Adeline Cabot, daughter of

Oliver and Eliza Jenkins Swift, of Falmouth, and a descendant from John Robinson, a passenger of the Mayflower in 1520.

The subject of this sketch, Henry Thomas Whitin, was instructed in the public and high schools of North Uxbridge and was graduated from Highland Military Academy, Worcester, Mass., in 1872. He became an apprentice in the Whitin Machine Works, owned and conducted by his uncle, J. C. Whitin (this belonged to Mr. J. C. Whitin alone), and this was followed by practical experience in the cotton mills of the Paul Whitin Manufacturing Company (Rockdale Mills), Northbridge, of which his father was president and manager. He was rapidly advanced to the positions of foreman, superintendent and agent, and was treasurer in 1906, his brother, G. Marston Whitin, being president of the corporation.

Mr. Whitin attended the Rockdale Congregational Church. He became a prominent member of the Masonic Fraternity, a Knights Templar, a member of the Republican Club of Massachusetts, of the Home Market Club of Boston, of the National Association of Manufacturers of New York, the Manufacturers' Club of New York, the New York Athletic Club, Tatonic Country Club, the Worcester Club of Worcester and the Country Club of Grafton.

Mr. Whitin married, Jan. 1, 1876, Fannie Cora, daughter of Scott and Mary (Lovett) Berry, of Worcester. Five children were born of this marriage, all of whom were living in 1911.

GUSTAVUS E. TAFT.

Gustavus Elzaplen Taft was born in Peacham, Vt., August 29, 1829; son of Cyrus and Lucinda (Morse) Taft, and a descendant of Robert Taft, who was born in 1640, probably in Scotland; came from England to Massachusetts Bay Colony with his wife, Sarah, and settled in Braintree in 1675; removed to Mendon in 1680 and died in 1725. Cyrus Taft removed with his family to Northbridge, Mass., in 1839, and his son attended the public schools of the town and the academy at Uxbridge. In 1846, at the age of seventeen, Gustavus E. Taft entered the Whitin Machine Shop as an apprentice, and he there found full scope for the development of his mechanical genius. In 1860 John C. Whitin made him superintendent of the Holyoke Machine Shops, and he returned to Whitinsville in 1864 to become superintendent of the Whitin Machine Shop, organized upon the dissolution of the firm of P. Whitin & Sons, with which firm he had learned his trade. He was identified with the extensive enlargement of the machine works, and was largely responsible for the growth and development of the business, being an excellent organizer

Gustavus E. Taft

of labor and manager of men. His mechanical skill applied to the tools used in the shops greatly increased their efficiency, and his inventions and improvements in machines manufactured, especially the cards, spinning-frames and looms used by cotton manufacturers, added largely to the reputation and patronage of the works. July 18, 1882, he patented the "Whitin Gravity Spindle," which he and Henry F. Woodmancy had invented, and patents were also obtained in England, France, Germany and Holland. This invention greatly increased the producing capacity of the spindle, which came into general use in all parts of the world where cotton is manufactured. In 1884 Mr. Taft became agent of the Whitin Machine Works corporation, and had the active management of the large business up to the time of his death. Mr. Taft married, November 8, 1855, Ruth L. Lamb, of Clinton, Me., and they had six children, who, with the mother, survived him. He died quite suddenly at his home in Whitinsville, Mass., June 24, 1888. Cyrus A. Taft, his oldest son, was appointed to the position held by Gustavus E. Taft, and held the same until 1904, at which time he gave up active business. He died February 6, 1908.

JOSIAH LASELL.

Josiah Lasell was born in Schoharie, Schoharie County, New York, Aug. 6, 1825, son of Chester and Nancy (Manning) Lasell. He was prepared for college at the Schoharie Academy, and was graduated from Williams College, A. B., 1844. He then studied law but, instead of seeking admittance to the bar, began teaching in the celebrated boys' school conducted by Prof. Piquet in Brooklyn, N. Y. From this school he went to Springler Institute, New York City, remaining several years. In 1852, with his elder brother, Prof. Edward Lasell, of Williams College, and his brother-in-law, Prof. G. W. Briggs, he aided in incorporating the Lasell Seminary at Auburndale, Mass., a school of high grade for young women. Soon after beginning the work, President Edward Lasell, the founder, died, and Josiah Lasell became joint proprietor with Professor Briggs, and he continued in this work up to 1860. Meantime, he had married, June 5, 1855, Jane, the only daughter of John C. Whitin, of Whitinsville, Mass., and in 1860 his father-in-law called him to his assistance in the conduct of the machine works he had purchased in Holyoke, Mass., where he remained until January, 1854, when Mr. Whitin sold the works in Holyoke and became sole proprietor of the machine works at Whitinsville. Mr. Lasell, too, went to Whitinsville to take charge of the books and accounts, and to give such other assistance to Mr. Whitin as he might need in his declining years. In 1870, when the machine works were incorporated, Mr. Lasell was made the treasurer of the corporation, and, at the same time, he shared with Mr. Whitin the care and responsibility of the office of president,

which the enfeebled health of his father-in-law made necessary. In 1882 Mr. Whitin died, and the directors at once elected Mr. Lasell president of the corporation, and he also continued to serve as treasurer up to January, 1886. It was largely under his inspiration and direction that the expensive additions to the works were carried on, and his success as a business man was as great as had been his grasp of the problem of teaching the young. In each of his enterprises he took wide and far-reaching views, and he believed in large accomplishments and in the possibilities of the future. He was also a master of details, and, in school or factory, he knew just what to do in an emergency and how to avoid confusion or panic. In public affairs he was placed in varied offices of trust and responsibility, especially in financial trusts involving the welfare of widows and minor children as affected by the settlement of estates.

Mr. Lasell left a widow and two sons, Chester Whitin Lasell and Josiah Manning Lasell, and two daughters, Catharine W., who married G. Marston Whitin, the treasurer of the Whitin Machine Works, and Jennie L., who married Dr. Ogden Backus, of Rochester, N. Y.

He died suddenly at his home in Whitinsville, Mass., March 15, 1886.

GEORGE CROMPTON.

George Crompton was born at Holcombe, near Bury, Lancashire, England, March 23, 1829. He was the son of William and Sarah (Low) Crompton, came to New England with his parents in 1839, and was educated in the public schools of Taunton, Worcester, and at Millbury Academy.

For a time he served as bookkeeper for his father, and, after his father's failure, was employed for a year in the Colt Pistol Factory at Hartford, Conn. Refusing an advantageous offer of advancement in this concern, he succeeded, after a personal visit to Washington, in getting an extension of his father's patent for seven years. He then formed a partnership with Merrill E. Furbush, and in 1851 the new firm started the manufacture of looms in the Merrifield buildings in Worcester.

The first looms this new firm built were (like the looms made by those who manufactured under licenses granted by his father, William Crompton) narrow looms; that is, they were looms of about forty-eight-inch reed space. These looms ran at a speed of forty-five picks per minute, that is, forty-five weft or cross threads were woven every minute. In 1857 Mr. Crompton constructed and patented a broad loom, nearly double the width of the old loom, and he demonstrated that this new loom could be run at what was then considered the extraordinary speed of eighty-five picks per minute. This was a revolutionary improvement. The production of the loom had been quadrupled, for both the width and speed were doubled.

On August 1, 1859, the firm of Furbush & Crompton was dissolved

George Crompton

with the understanding that the territory covered by the patents owned by the firm should be divided, so that Mr. Crompton would hold the New England States and New York, while the remainder of the United States should belong to Mr. Furbush.

During 1861-65 Mr. Crompton added to his business of manufacturing looms that of making tools for the manufacture of gun stocks, which were sold to gun makers, but at the end of the Civil War the entire resources of the works were again directed to the construction of weaving machinery. He took out over 100 patents for improvements on looms and for devices outside of his own business, likewise securing numerous patents in Europe. He exhibited his loom at the Philadelphia Centennial Exhibition, where he obtained a medal, and at the Paris Exposition in 1867, where all the leading manufacturers of Europe were represented, he received a gold medal.

Mr. Crompton in the late seventies introduced the Keighley dobby into this country. With Mr. Horace Wyman, who was associated with him, he improved this harness motion considerably, simplifying it and altering its position (which on English looms had always been in the centre of the arch) to the end of the arch, where it could be repaired or fixed more easily, and also getting rid of the annoyance of having the oil drop from this mechanism on the warp in the loom. With Mr. Wyman also, he invented and improved the well-known Crompton gingham loom, which has since then become the standard gingham loom of this country.

Mr. Crompton was actively interested in civic and public affairs, and served the city of Worcester as a member of the Council, 1860-1; as an alderman, 1863-64. It was largely owing to his efforts that the soldiers' monument, designed by Randolph Rogers, was placed in the public park. Mr. Crompton married, Jan. 9, 1853, Mary Christiana, daughter of Charles Pratt, of Hartford, Conn., and had twelve children. He died at Worcester, Mass., Dec. 29, 1886.

WILLIAM CROMPTON.

William Crompton, son of Thomas and Mary (Dawson) Crompton, was born in Preston, Lancashire, England, Sept. 10, 1806. He was a practical weaver both by hand and power, an excellent cloth designer and an admirable mechanic. While still a young man he was made superintendent of the cotton mills at Ramsbottom-on-the-Irwell, Lancashire, where he gained a wide experience in the manufacture of cotton; his natural inventive talents evincing themselves in the improvements which he made on the machinery in this mill.

In 1836, at the age of thirty, he came to the United States in search of wider opportunities, and entered the employ of Messrs. Crocker and Richmond, at Taunton, Mass. Here, having been requested to weave a

certain pattern of goods, which the looms in use there were not fitted to produce, he invented and made a loom of extremely novel design, in that it was the first loom in which the figure or pattern to be produced could be made up on what is known as a chain. This chain is a series of bars or lags, held together by links, so as to form a chain of bars, hence the name. On these bars or lags are rollers or pins, placed in such position that as the chain revolves it lifts, at certain predetermined intervals, levers, which in turn cause the harnesses to be raised in such order that the desired design or pattern is produced upon the loom.

The loom invented by William Crompton overcame two great disadvantages of the cam loom—the limitation of harness capacity and the necessity of changing the cams in order to change the pattern, because its construction made it possible in a very limited space to control and operate a great number of harnesses, and made it extremely easy to change from one pattern to another. Finally, by William Crompton's invention, any harness could be raised or lowered at any time, and exceedingly complicated patterns could for the first time be woven by power. Another innovation in this loom was that the warp was made to move up and down, this double motion giving more room for the shuttle to fly from side to side. For this invention Mr. Crompton received a patent numbered 491 and dated November 23, 1837. Owing, however, to the general depression of the textile industry here, he went to England and obtained letters patent, and his looms were later put into operation in that country.

In 1839 he returned to this country, with his wife, Sarah (Low) and his family, including his son George, and settled in Taunton. About this time the Middlesex Mills, of Lowell, wishing to manufacture a cloth similar to a piece which had been made by hand in France, requested Mr. Crompton to come to Lowell. Mr. Crompton accepted this invitation and applied his patented fancy harness motion to the looms in the mill, and demonstrated that with this motion the desired pattern could be woven. *Thus, in 1840, at the Middlesex Mills in Lowell, fancy woolens were, for the first time, woven by power.* Mr. Crompton shortly after this entered into arrangements with Phelps & Bickford, makers of plain looms in Worcester, to manufacture his looms under a royalty, during the life of the patent, he himself operating a cotton mill in Northville, now a part of Worcester. This mill being destroyed by fire in 1844, Mr. Crompton went to Millbury, where he engaged in the manufacture of cotton and woolen cloth. A few years later, becoming financially embarrassed, he retired from business and moved to Hartford, Conn. The great success that his son George made of the Crompton looms brought about many imitations, especially in Continental Europe. All fancy power looms, excepting only Jacquard looms, still use the pattern chain originally invented by William Crompton, thus being in their most essential mechanism Crompton looms.

Mr. Crompton died at Windsor, Conn., May 1, 1891.

LUCIUS JAMES KNOWLES.

Lucius James Knowles, inventor, was born in Hardwick, Massachusetts, July 2, 1819, son of Simeon Knowles, a prosperous farmer. He was brought up on his father's farm, sent to the public school, and in due time to the Leicester Academy, where he completed three terms, and, when seventeen years of age, he found employment as clerk in a general store in Shrewsbury, and in 1838, although not of age, he was admitted to partnership. His leisure hours were devoted to perfecting various inventions, including musical instruments, steam engines, and a safety steam boiler feed regulator, which he perfected in 1840, and on which he obtained a patent. In 1840 he disposed of his interest in the Shrewsbury store and devoted himself to mechanical studies and experiments. He built an electric engine, and, in 1842, turned his attention to the development of the science of photography, invented a camera and material for the use of photographers, and for the purpose of combining business with study, he operated a photographic gallery for two years, selling it out in 1844. He then engaged in the manufacture of thread at New Worcester, Mass., in the mill owned by Albert Curtis on the site of the Hale mill. His purpose was to put to practical use a spooling machine, invented by him, which done he removed to Spencer in 1847 and engaged in the manufacture of cotton warp yarn. He removed his business to Warren in 1849, where he added machinery for manufacturing woolen goods. He sold out his interest in the woolen manufacturing business in 1860, having in 1859 obtained a patent for an improved method of operating the valves of pumping engines, and the first steam pumps made under his patent were made for him by contract. The invention proving of great value in mining operations as well as for general use, he began to manufacture them in his own machine shop at Warren, in 1863, where he had the previous year begun the manufacture of his patented safety steam boiler feed regulator, invented in 1840. He had been led, in his business as a manufacturer, to study the power loom, and this resulted in the Knowles loom which made his name known throughout the textile manufacturing centres of Europe and America. In 1862 he induced his brother, Francis B. Knowles, to join him in the manufacture of the Knowles tape-loom. For this purpose they set apart a room in the pump works at Warren, and their first working force was one wood worker and two machinists; but the demand for the new loom soon caused the increase of both working force and room, and to obtain the latter he sold a half interest in his steam pump to the George F. Blake Company, of Boston, and the manufactory of pumps was transferred to that city. In 1866 the shops of the loom works were transferred to Worcester, in rooms on Allen's Court, and, in 1879, they were crowded for room and removed to the junction shops, and. later, to a new building on the corner of Tainter and Grand Streets, extending

to the railroad tracks on Grand Street, in 1889. The business was consolidated with that of the Crompton Loom Works, in 1897, and incorporated as the Crompton & Knowles Loom Works with a capital of $3,000,000. The Star Foundry, of Worcester, was added to the combination in 1897, and the Gilbert Loom Company in 1899. The Crompton close-shed loom, the Knowles open-shed loom, and the Gilbert loom, for weaving Kentucky jeans and other coarse goods, gave employment to 1,500 skilled machinists, and the product of the works found a market in the principal manufacturing towns of the United States and Europe.

Mr. Knowles served the Commonwealth of Massachusetts as a representative in the General Court, in 1862 and 1863; as a state senator in 1869. He served the city of Worcester as a member of the Common Council; was a director of the Central National Bank; in the State Mutual Assurance Company; president of the People's Saving Bank, and president of the Worcester Board of Trade. He received the honorary degree of M. A. from Williams College in 1865.

Mr. Knowles died suddenly while on a visit to Washington, D. C., of neuralgia of the heart, Feb. 25, 1884.

FRANCIS B. KNOWLES.

Francis B. Knowles was born in Hardwick, Mass., Nov. 29, 1823. His father, Simeon Knowles, was an industrious and well-to-do farmer, and his sons were accustomed to work on the farm and in the workshop.

Francis was educated in the public schools and academy of his native town, and then taught the district school at Dana, Mass., through a winter term. His next school was at Gloversville, New York, but at the end of his first term he determined to change his occupation and obtained a position as travelling salesman for a glove manufacturer of Gloversville. He was most successful in this occupation, and on April 1, 1845, he began the manufacture of buckskin gloves on his own account, meeting with considerable success. He subsequently engaged in the clothing business up to 1862, when he removed from Gloversville, New York, to Warren, Mass., to take up the manufacture of looms in connection with his brother, Lucius J. Knowles, four years his senior, and the inventor of a pumping engine of special value in mining operations, of the safety steam boiler feed regulator, and of an improved loom which came into general use in many of the cotton manufactories of the United States and abroad. The two brothers formed a partnership, and F. B. Knowles devoted his whole time to the manufacture of his brother's loom, and saw the business expand from a small room in which three men worked, to an immense factory

employing over 600 skilled workmen. The loom works at Warren were removed to Allen's Court, Worcester, Mass., in 1866, and to the junction shop, to secure needed room, in 1879. A new building was erected in 1889 on the corner of Tainter and Grand Streets, extending to the railroad tracks on Grand Street.

The Knowles Loom Works and the Crompton Loom Works were consolidated and incorporated as the Crompton & Knowles Loom Works in 1897, with a capital of $3,000,000. The Star Foundry was added to the concern in March, 1897, and the Gilbert Loom Company in 1899, and the combined business, as operated by the Crompton & Knowles Loom Works, Worcester, Mass., gave employment to about 1,500 hands in manufacturing the Crompton close-shed and the Knowles open-shed looms, and the Gilbert loom to weave Kentucky jeans, cartridge belts, carpets and other coarse fabrics. The officers of the company in 1910 were: Charles H. Hutchins, president, and L. J. Knowles, treasurer, and the stock was held by forty-five individual stockholders. Mr. Knowles married, Dec. 23, 1845, Ann Eliza, daughter of David Poole. Mrs. Knowles died Feb. 24, 1865, and he married, secondly, April 23, 1867, Hester A., daughter of John Reynolds and Fanny Wightman Greene, of Worcester. The vigorous climate of New England affected his health as he increased in age, and he found relief by spending his winters in Florida, where he became financially interested in the development of the town of Winter Park and he was one of the largest stockholders in the enterprise, which was incorporated as the Winter Park Company.

Francis B. Knowles died in 1890.

CHARLES HENRY HUTCHINS.

Charles Henry Hutchins was born in East Douglas, Mass., Jan. 13, 1847; the son of Charles Hutchins, of Saco, Me., and Harriet N., daughter of Oliver Hunt, of East Douglas, Mass., a pioneer axe manufacturer in this country. Mr. Hutchins was educated in the public and high schools of his native town, and then put in two years in his father's axe factory, where he learned both practical mechanics and business system. The next two years he spent as a clerk in a country store in the town, after which he entered the dry goods house of Horace Sheldon & Co., of Worcester, with which establishment he remained from 1867 to 1874.

On withdrawing from Horace Sheldon & Co., he organized the firm of C. H. Hutchins & Co., and engaged in the manufacture of tapes and webbings, the business soon afterwards being incorporated as the Hutchins Narrow Fabric Company. In 1884, he became a member of the firm of

L. J. Knowles & Bro., loom manufacturers, of Worcester, after the death of Lucius J. Knowles, the senior member of the firm. On its incorporation as the Knowles Loom Works in 1835, he became treasurer of the corporation, and in 1890, on the death of Francis B. Knowles, his father-in-law, he succeeded him as president. In 1897, Mr. Hutchins became the first president of the new Crompton & Knowles Loom Works, of Worcester, the result of a consolidation of the Crompton Loom Works, of Worcester, and the Knowles Loom Works, in which arrangement he was the prime mover.

Mr. Hutchins was a man of large affairs in the manufacturing world, and was associated with many other important enterprises. From 1899 he has served as president of the United States Envelope Company, the largest concern of its kind in the world. He served also as a director in national and savings banks and trust companies; was one of the founders of the Hospital Cottages for children at Baldwinsville, Mass., and was a director of the Home for Aged Men and the Home for Aged Women in Worcester. He was a member of the Piedmont Congregational Church and an active supporter of church works. He married Eliza E. Knowles, daughter of the late Francis B. Knowles, in 1873.

EDWIN TYLER MARBLE.

Edwin Tyler Marble, born in Sutton, Mass., Aug. 18, 1827. He was the eldest son of Royal Tyler and Ann B. (Clement) Marble. The family of Marble has long been identified with the town of Sutton. Samuel, the immigrant ancestor, settled in Andover before 1660, coming from Wales. He was a brick mason, making his own bricks, and was admitted a freeman in 1678. Freegrace, his son, was born about 1690, and his marriage to Mary Sibley was the first in Sutton. He was one of the original proprietors of the town, a brick mason, and helped to build the old State House in Boston. Malachi, son of Freegrace, and great-grandfather of Edwin T. Marble, was born in Sutton, where he became prominent. He enlisted April 11, 1759, in Colonel John Chandler's regiment, and during the French War was also in Captain Samuel Clark Power's company, Brigadier-General Ruggles' regiment. During the Revolution he was collector of taxes for Sutton. Andrew, grandfather of Edwin Tyler, was the oldest son of Malachi, and was born in Sutton in 1761. He was a mail-carrier between Boston and Hartford. Royal Tyler, father of Edwin Tyler, was fourth child of Andrew, born in Sutton in 1797. He built up a reputation throughout the country for his ability to raise prize stock, and he was much interested in the Worcester County Agricultural Society in its

[illegible] WILLIAMS [illegible]

Edwin T. Marble,

JAMES H. LAMB CO.

early days. He was commissioned lieutenant of the 5th regiment, Sept. 20, 1826, and was captain of the Sutton rifles in 1830 and 1831. He married Ann Bailey Clement, of Worcester, Sept. 27, 1825, she being a daughter of Moses and Sarah (Bailey) Clement, a descendant of old Essex County families.

The subject of this sketch was educated in the public schools of his native town, and also at the Worcester County Manual Training School, that being the old name of the Worcester Academy, having removed to Worcester with his parents in 1841. At the age of eighteen he entered the machine shop of Albert Curtis, where he served an apprenticeship of three years. He then worked in various machine shops in the city of Worcester as a journeyman, foreman and superintendent; for some time he was in the employ of A. & S. Thayer, and afterwards was foreman for Thayer, Houghton & Co., manufacturers of machinists' tools. Later he was superintendent for E. C. Cleveland & Co., manufacturers of woolen machinery. In 1850 he worked for a time in Shelburne Falls, but retained his residence in Worcester. In 1863 he entered into partnership with Mr. Albert Curtis, who had established the business in 1831, with John Simmons and Abel Kimball as his partners in the manufacture of machinery for the finishing of woolen cloth, including shearing machines, brushing machines, gigs, nappers, etc., Mr. Curtis having continued the business with other partners or in his own name up to that time. The new firm, under the style of Curtis & Marble, began business in the same small shop on Webster Street where the junior partner had learned his trade; Mr. Marble assuming the management of the machine shop and Mr. Curtis devoted his time to his woolen mills. The business grew steadily from that time on, the working force being largely increased and the partnership continued until April, 1895, when Mr. Marble bought the interests of Mr. Curtis and became sole proprietor. The Curtis & Marble Machine Co. was incorporated December 31, 1895, with a capital of $75,000, Mr. Marble being president and treasurer, and retaining these positions until his death. The other officers were his four sons: Edwin H. Marble, vice-president; William C. Marble, secretary; Charles F. Marble, cashier; Albert C. Marble, superintendent. In 1897 an entire new plant was built at 72 Cambridge Street, and the business moved into a modern brick factory, the main building being three hundred feet long by sixty-four feet wide, where the company made a most extensive line of finishing machinery for all textile fabrics, and also wool burring, picking and mixing machinery.

A republican from the organization of the party, Mr. Marble always took a prominent and active part in public affairs. In 1870 he was elected representative to the General Court, but declined a second term, and he served in the State Senate in 1887 and 1888. He was a member of the school board in 1860, and again from 1872 to 1880; was elected to the common council in 1866 to 1868, and was a member of the Board of Alder-

men from 1869 to 1872. He was six years a director of the Free Public Library, being president of the board the last year. He was an active and influential member of the Worcester County Mechanics' Association, which he joined in 1846, and was trustee during the intervening time (twelve years), and president in 1878 and 1879. His other interests were many and varied. He was a director of the Worcester Safe Deposit & Trust Co., which has grown into the Worcester Trust Co., of which he was a director until his death. He was trustee and vice-president of the Peoples' Savings Bank, and was for many years a member of the committee on investments. He was a member of the executive committee and vice-president of the Home for Aged Men from its organization in 1891, and president during 1909-10. He was a member of the Board of Trade and a director for many years; a member of Worcester County Agricultural Society; also a member of the National Association of Cotton Manufacturers. He was affiliated with the Piedmont Congregational Church from 1875 and served in many offices, being deacon for nearly thirty-five years.

Mr. Marble married, in Shelburne Falls, Mass., October 23, 1850, Harriet Hamilton, daughter of Henry Prentice and Achsah H. (Clement) Chase. Her father was a descendant of Aquila Chase, immigrant and pioneer. She was a schoolteacher while in Worcester and taught in the public schools. Mrs. Marble died in April, 1892. Their children were Edwin H., Harriet A., William C., Charles F. and Albert C. The four sons were associated with their father in business; the daughter, Harriet A., lived with her father, and died in 1906. Mr. Marble died July 3, 1910, after a brief illness, in his eighty-third year.

ALBERT CURTIS.

Albert Curtis was born in Worcester, Mass., July 13, 1807. He was a son of Samuel and Eunice (Taft) Curtis, and descended through Samuel and Mary (Stone-Coggin) Ward Curtis, Ephraim and Mary, daughter of Isaac and Sibyl (Collins) Rice Curtis; Ephraim and Mary (daughter of David and Susanna Stone) Curtis; Joseph and Abigail (daughter of Captain John and Sarah (Busby-Cakebread) Grout Curtis; from Henry Curtis, who came to New England in 1635 in the "Elizabeth and Anne," and settled at Watertown, Mass. He was then twenty-seven years old, and he married Mary, daughter of Nicholas Guy, of Upton Gray, Southampton, England, who came to New England in 1838 in the ship "Confidence" and settled at Watertown, Mass. Henry Curtis was a wheelwright by trade.

Albert Curtis was the sixth son of his father, who died in 1811 when the boy was very young. Albert, from the age of nine to thirteen, lived

with an uncle in Auburn, where he attended district school in winter and assisted about the farm in summer; he then went to reside with a relative in Tioga County, New York, where he followed the same routine of life. When seventeen years of age, he returned to Worcester, where he served an apprenticeship of three years in the shops of White & Boyden, manufacturers of woolen machinery at South Worcester. At the close of his apprenticeship he was employed by the firm as a journeyman. In 1829 he went to Pittsburg, Pa., and returning to Worcester in 1831, entered into partnership with John Simmons and Abel Kimball, under the firm name of J. Simmons & Co., and engaged in the manufacturing of brushing, shearing and napping machines for finishing woolens. This partnership was dissolved in 1832, and thereafter the firm was known as Simmons & Curtis. In 1833 Mr. Curtis purchased Mr. Simmons' interest and carried on business alone until 1834, when he associated himself with Mr. William Henshaw. The firm was now known as Curtis & Henshaw and so continued for four years.

In 1840 Mr. Curtis purchased of Mr. Wheelock the water privilege and mill building and two full sets of satinet machinery. In 1842 this factory, as well as his machine shop, was destroyed by fire, and he promptly rebuilt them, and in the same year built a factory, part of which he leased to Sumner Pratt for the manufacture of sewing thread. He acquired an equal interest in this business, and, in 1844, he bought out Mr. Pratt and put in looms for making cotton sheetings, and the following year built a large factory just south of this mill. In 1852 he bought the Trowbridge village and mill property with the large farm attached, these being situated about three-quarters of a mile from his other factories. Here, after making extensive improvements, he also began to manufacture sheetings.

In 1857 he began the manufacture of satinets, and, in 1863, he took Edwin T. Marble into partnership in the manufacture of woolen machinery, and this portion of his business was thereafter conducted under the firm name of Curtis & Marble, the junior partner assuming the active management of the machinery business, while Mr. Curtis continued with his mills. In 1895 Mr. Curtis sold his entire interest in the firm of Curtis & Marble to Mr. E. T. Marble, who then formed the corporation of Curtis & Marble Machine Company.

He continued the manufacture of cotton sheetings at the Trowbridge Mill until 1870, when most of it was destroyed by fire, and it was reconstructed as a woolen mill. In 1871 Mr. Curtis fitted his other factory, built in 1845 and known as the South Mill, for the production of woolen goods, and, in 1871 put in looms for the weaving of horse blankets.

In 1880 Mr. Curtis incorporated the mill property and water rights at New Worcester as the Curtis Manufacturing Company.

Shortly after his death, in 1898, the controlling interest was bought by Charles G. Stratton, who, in 1909, sold the real estate and water rights

to the Worcester Electric Light Company, who have razed the old buildings and erected a modern electric power plant on the site.

Mr. Curtis built the first machine made in this country for shearing or trimming cotton goods. These machines were used to remove fuzz from cotton cloth, which in former times had been accomplished by singeing or burning. A shearing machine made in France was sent from Pawtucket to be repaired; this had one set of shears. Mr. Curtis made improvements and built machines superior for the purpose. The Curtis & Marble machine has two to six sets of shears, and one machine can do as much as twelve of the old type did in 1830.

He was a member of the government of the old town of Worcester as selectman, 1840-41; he was also a member of the first Common Council of the city in 1848, and an alderman in 1857, and was trustee of the City Hospital. He was for some time vice-president of the Worcester Society of Antiquity, and a member of kindred organizations.

Mr. Curtis built the Curtis Chapel at Hope Cemetery, and presented it to the city. He was also liberal in his benefactions to the Old Men's Home, the Young Men's Christian Association, the Young Women's Christian Association and to the Union Church. His gifts in other directions were liberal and numerous.

Mr. Curtis married, 1832, Mrs. Sally K. Griffin, who died, leaving no children by this marriage. He married, in 1880, Mrs. Bancroft, widow of Rev. David Bancroft. Mr. Curtis died suddenly in Worcester, July 27, 1898.

ABRAHAM MARLAND.

Abraham Marland was born in Ashton Parish, Lancashire, England, Feb. 22, 1772, son of Jonathan and Martha (Lawton) Marland. His mother died in 1776, and her brother, John Lawton, a woolen manufacturer of Ashton, took charge of the boy and sent him to school until he was eight years of age, when he began his apprenticeship in the woolen mill. He was but fifteen years old when his uncle died, leaving him possessed of an excellent knowledge of the business, but entirely dependent upon himself for a livelihood. He readily obtained employment in another factory in the neighborhood, but shortly after went to Leeds, and in that place and at Holbeck, on the opposite side of the river, he was employed in woolen mills for four years. At the opening of the nineteenth century he embarked for America with his wife and infant child, arriving in Boston, Mass., September 17, 1801. He went directly to Pawtucket, R. I., where Samuel Slater was operating a mill for spinning cotton yarns, for the purpose of obtaining work or advice in regard to finding employ-

ment for his skill and his savings. Slater advised him to invest his money in land and its cultivation, and not to risk it in the precarious business of a manufacturer. This was contrary to Marland's plans, and he determined to pursue the vocation of which he felt himself a master. The manufacture of wool was at a low ebb in America, and the attention of manufacturers was directed to cotton, which was then much in demand as warp to be used with flax and wool, and for calico as a popular dress goods. His skill in spinning wool yarn served him in operating the spinning jennies for cotton yarn, and the next two years were spent in the Beverly Cotton Manufactory. In August, 1803, he removed to Lynnfield, where he engaged in manufacturing cotton yarns for knitting and weaving. This business he continued up to May, 1807, when he transferred his machinery to Abbot Village, Andover, Mass. He built a small mill fifteen by forty feet, two stories high, and in this conducted the business of the Abraham Marland Cotton Factory up to 1811. Thomas R. Appleton was the selling agent for the cotton warp, filling and knitting yarns produced by the mill. In 1811 Mr. Marland gave up the business of working in cotton and changed his carding and spinning machinery to that for working wool; he also added looms adapted to weaving satinets and found profit in their manufacture up to the outbreak of the War of 1812, when he adapted his mill to weaving army blankets. From 1813 to 1819 he was interested in a mill established by James Schofield at the mouth of the Cochicawick River, in North Andover. Later the depreciation in government bonds received in payment for blankets so decreased his profits that he changed the product of his mills to making flannels, which was his chief output thereafter. In 1821 he secured from Peter C. Brooks a lease of the old powder mill erected in 1775-76 at Andover by Samuel Phillips, Jr., and transformed to a paper mill in 1789. The lease was to run for twenty years, and Marland erected on the site the first brick mill, the oldest of the present Marland Mills, and also a block of brick tenements for the operators. The machinery transferred from the old mill was supplemented by new machinery, and the mill was in full operation in the fall of 1822. The venture was profitable, and on September 1, 1828, Mr. Marland purchased the property, including the mill privilege on both sides of the river, with the woolen mill of 1822, the old paper mill, a grist mill and thirty acres of land. He erected a new mill in 1832, and in 1834 incorporated the business as the Marland Manufacturing Company, with a capital stock of $60,000, the stockholders being Abraham Marland, his sons, John and William S. Marland, and his son-in-law, Benjamin H. Punchard. Abraham Marland was president of the corporation up to the time of his death, and Benjamin H. Punchard was the first treasurer of the company. Mr. Marland was a member of the Episcopal Church, and, there being no church in Andover, he carried out a long-cherished desire in 1835, when, with his sons and son-in-law, he secured the establishment of Christ Church and liberally supported it dur-

ing its early days. He gave the lot adjoining the church for the site of a rectory and erected on it a commodious dwelling for the rector. With his son, John, he also gave the ground for a cemetery. Mr. Marland married, Feb. 3, 1800, Mary Sykes, of Holbeck, England. He died at Andover, Mass., Feb. 20, 1849.

ROBERT ROGERSON.

Robert Rogerson was born in Boston, Mass., Jan. 30, 1786; son of Dr. Robert Rogerson and grandson of the Rev. Robert Rogerson, who was born in Portsmouth, England, and about 1740 was sent as assistant collector of revenue by the home government to the American colony of Virginia. Robert Rogerson was brought up in Boston, where he was educated in public and private schools. He was engaged in business on his own account as a wholesale merchant in American goods when he was twenty-seven years of age. His store in 1813 was located at No. 21 Dock Square, Boston, and there, previous to that date, he had established in his store building machinery by which he manufactured cotton yarns. The power that moved his spinning frames was furnished by a horse kept quietly at work in the cellar of the building The business conducted in such limited quarters was successful as well as remunerative, and in 1813 he invested capital in the business of manufacturing cotton yarns by water-power by purchasing the Clapp Mill at North Uxbridge, Mass., removing his entire Boston spinning plant to that mill in 1815. He operated the mill with few additions in machinery or accommodations up to 1823. In 1820 he received into partnership Oliver Eldridge, who was interested in the investment of capital in various manufactories in Worcester county and elsewhere, and the firm of R. Rogerson & Company became the proprietors of the business of Robert Rogerson, of Boston, wholesale dealer in domestic and foreign dry goods, the business having in the mean time been transferred from Dock Square to 68½ State Street, and in 1823 R. Rogerson & Co. removed to 26 Merchants' Row, and in 1826 to 38 South Market Street. The Clapp Mill was removed in 1823 to the opposite side of the public highway to make room for a new stone mill, the building being 100 feet long, 40 feet wide and three stories high, with both basement and attic. The machinery was built on the premises in the best manner then known to manufacturers and regardless of cost, so as to insure as fine and perfect goods as could be produced in the United States. In 1827 a second mill was erected, constructed of like material and of the same dimensions and general appearance, on the opposite or eastern side of the Mumford River. To the mill erected in 1823 he gave the name "Crown Mill," and

to that erected in 1827. "Eagle Mill," the names having apparently been selected by the owner in compliment to both the country of his ancestors and his own native land The expense of building these two mills and laying out, building up and beautifying the village, created by the presence of two such flourishing mills, approximated $200,000. A contemporary writer describes these improvements in the following words: "The village has more the quality of perfection than almost any other manufacturing village in Massachusetts." Another says: "The whole village is laid out with so much taste that it attracts the notice of any stranger who may pass through it." Mr. Oliver Eldridge retired from the firm of R. Rogerson & Co. in 1827, and Handel Rogerson, a younger brother of the senior partner, took his place. On March 12, 1830, the business of Robert Rogerson, sole owner of the Crown and Eagle Mills, was incorporated under a special act of the legislature of Massachusetts as: "The Proprietors of the Crown and Eagle Mills," the incorporators being Robert Rogerson and Handel Rogerson, Robert Rogerson conveying the property to the corporation for $225,000 and Handel Rogerson assuming the general management of the mill as resident agent. The financial crisis of 1837 put a stop to the continuous and accelerating prosperity of the mills. A writer mentioning its effect on Mr. Rogerson's enterprise says: "The magnificent property that had been erected by his genius and enterprise, and through which he furnished the means of industry and emolument to many, passed into the hands of strangers." The creditors of Mr. Rogerson organized a new corporation, December 16, 1840, under the name of the Uxbridge Cotton Mills, the charter by the state of Massachusetts bearing date March 20, 1840, authorizing the sale of stock to the full sum of $100,000; Charles W. Cartwright, Henry Hall, James Read, George Morey, Daniel Denny, Benjamin Humphrey and Benjamin F. White, all prominent merchants and capitalists of Boston, owning the entire stock. The business of the Uxbridge Cotton Mills was conducted by the agents of these proprietors up to April 1, 1849, when the mills were stopped. On May 8, 1849, the property was sold to Paul Whitin & Sons, of Whitinsville, who added the fine plant of the old Eagle and Crown Mills to their other successful cotton mills and cotton machinery enterprises, using the charter and name of the Uxbridge Cotton Mills corporation. In 1851 the Whitins increased the capacity of the mills nearly one-half by the erection of a brick building 120 feet long and of uniform width and height, with the two granite mills uniting them by spanning the river with an arch, making the mills with the intervening structure 320 feet long. In the settlement he made with his creditors, Robert Rogerson gave a preference to the employees and small creditors, mostly business men of Uxbridge of comparatively small resources; his debts to such he paid in full, while between the capitalists of Boston and New York, who had enjoyed a profitable business connection with him for many years, the loss was equitably shared. He removed

his family from Boston to his farm at Uxbridge, near his mill, where he devoted himself to the cultivation of the soil up to 1847, when he returned to Boston. In his home and social life he was known as a man of extensive reading, of much thought, of public spirit, of deep interest in the welfare of the community and of his employees and dependents. In business he was stern, grave, reticent and far too independent. He was possessed of rare musical talent, and his skill as an organist was displayed upon the fine organ given by him to the Unitarian Society of Uxbridge. He was president of the Handel & Haydn Society of Boston, the oldest and, during its existence, the foremost musical musical organization of the United States. Mr. Rogerson died in Boston, Mass., August 11, 1862, in the seventy-seventh year of his age.

ARTHUR T. LYMAN.

Arthur Theodore Lyman was born in Boston, Mass., Dec. 8, 1832; son of George Williams and Anne (Pratt) Lyman; grandson of Theodore and Lydia (Williams) Lyman and of William and Mary (Williams) Pratt, and a descendant of Richard and Sarah (Osborne) Lyman through Captain Moses and Mindwell (Sheldon) Lyman, Rev. Isaac and Sarah Plummer Lyman and Theodore and Lydia Williams Lyman, his paternal grandparents. Richard Lyman, the immigrant, came from High Ongar, Essex, England, to Charlestown, Massachusetts Bay, in the ship "Lion" in 1631, and in 1635 removed to Hartford Colony on the Connecticut River and thence to Northampton, Mass. The Lymans became prominent in the development of industrial and educational interests in New England and in public affairs of the commonwealth of Massachusetts. George Williams Lyman, who, with his father, had been engaged in trade with India, China, Europe and the northwest coast of America, became later largely interested in manufacturing companies in Lowell, Lawrence and Holyoke. He was treasurer of the Lowell Manufacturing Company, 1831-41; of the Hamilton Manufacturing Company, 1833-39; of the Appleton Company, and of the Lyman Mills, Holyoke, Mass.

Arthur Theodore Lyman was prepared for college in Boston and Waltham under private tutors, and was graduated from Harvard College with the class of 1853, receiving his master's degree in 1857. He entered trade as a clerk in the counting room of Samuel and Edward Austin, India Wharf, Boston, the firm being engaged in the East India trade, and after eighteen months' service he travelled in the various European countries for study and observation, 1855-56. On his return to Boston in 1856 he was engaged in the East India trade on his own account. In 1860 he was made

Arthur T. Lyman

JAMES [illegible] LAMB SC

treasurer of the Hamilton Manufacturing Company, chartered in 1825, which corporation his father had served in the same office, 1833-39. He was made treasurer of the Appleton Company, organized in 1828, of which company, also, his father had been treasurer. Arthur T. Lyman served both of these corporations as treasurer up to the close of 1863. He then became selling agent for various cotton mills as a member of the firm of J. W. Paige & Co., Boston, and in 1866 accepted the treasurership of the Hadley Company, of Holyoke, Mass., serving until 1889. In 1881 he was chosen treasurer of the Lowell Manufacturing Company, holding the office until the union of the Lowell Manufacturing Company with the Bigelow Carpet Company in 1900. In 1886 he served temporarily as treasurer of the Tremont & Suffolk Mills, and likewise served temporarily the Merrimack Manufacturing Company.

Mr. Lyman was a director of the Pacific Mills, Merrimack Mfg. Co., Lawrence Mfg. Co., Tremont & Suffolk Mills, Lowell Machine Shop, Boott Cotton Mills, Middlesex Company, Massachusetts Cotton Mills, Massachusetts Mills in Georgia, Dwight Mfg. Co., Bigelow Carpet Co., Boston Mfg. Co., Waltham Bleachery & Dye Works, being also president of many of those corporations.

In addition to these various interests, he was director of the Massachusetts Hospital Life Insurance Company and of the Massachusetts National Bank, 1862-98. He also served as a trustee of the Provident Institution for Savings in Boston. He was elected President of the Boston Athenæum in 1899, having previously been secretary, treasurer and trustee. He was a member of the corporation of the Massachusetts Institute of Technology and was an overseer of Harvard College, 1892-99. He was aide-de-camp, with the rank of colonel, on the staff of Governor Alexander H. Rice, 1876-79.

Mr. Lyman married, on April 8, 1858, Ella, daughter of John Amory and Elizabeth E. (Putnam) Lowell, of Boston, and their children in the order of their birth were: Julia, Arthur (Harvard, 1883), who became a lawyer and manager of real estate and other trusts; Herbert (Harvard, 1886), who became the treasurer of the Hadley Company, Holyoke, Mass., was for a time manager of the New England office of the American Thread Company and was made treasurer of the Merrimac Manufacturing Company in 1908; Ella (Mrs. Richard C. Cabot), member of the Massachusetts State Board of Education and of the Council of Radcliffe College; Susan Lowell (died 1878); Mabel, and Ronald Theodore, who became treasurer of the Boston Manufacturing Company, Waltham, Mass., and of the Waltham Bleachery & Dye Works.

ERASTUS BRIGHAM BIGELOW.

Erastus Brigham Bigelow was born at West Boylston, Mass., April 2, 1814; son of Ephraim and Polly (Brigham) Bigelow. His father was a man of small means, and the boy, at the age of ten, found a place on a farm, where he worked hard for three years. In the winter he attended the district school, and what he there learned kindled on a naturally bright mind a desire for a liberal education, which could be obtained only through his own efforts, and for several years this was his sole aim and object.

In 1827 his father established a mill for the manufacture of cotton yarns and put Erastus to work in the mill, where, at the age of fourteen, he invented a hand loom for weaving cotton webbing for suspenders. The demand for the webbing did not justify the employment of an operator to work the machine, and he abandoned it. His next venture was the perfecting of a machine for making cotton cord, which earned the youthful inventor the sum of one hundred dollars the first year, but a decline in the demand for the article caused the abandonment of this machine also. Having by these means acquired a small capital with which he paid for his tuition at the Leicester Academy, his progress was such that his teacher recommended a collegiate course for the lad, but his father considered a trade a surer and safer means of earning a livelihood.

Averse to the occupation of spinning, Erastus went to Boston, where he obtained employment in the wholesale and retail establishment of S. F. Morse & Co. While there, he taught himself the art of stenography and compiled and published a book entitled "The Self-Taught Stenographer." He sold it readily in Boston, then took a partner and had a larger edition printed, but he failed to place this in the hands of the public and found himself heavily in debt. He was now eighteen years old. His father meanwhile had formed a partnership with the celebrated John Smith, and a new mill had been built for their operations. This left the old mill idle, and Erastus entered into partnership with John Munroe and there established a twine manufactory. Bigelow & Munroe next ran a cotton factory at Wareham, Mass.: the venture ended disastrously at the end of nine months, and young Bigelow went to New York, where he studied the art of penmanship, and for some time earned a living by teaching it. This desultory sort of existence did not satisfy him, and he resolved to become a physician; passed another winter in classical studies at Leicester and entered upon the study of medicine, in which he encountered many difficulties, owing to the lack of early preparation.

His attention was now drawn to the possibility of perfecting a loom for the weaving of Marseilles or knotted quilts, having years before seen similar productions woven by the slow and necessarily costly process of the hand loom. He suspended his medical studies to solve this problem, and having constructed a satisfactory working model, proceeded to Boston

in search of capital, interested Freeman, Cobb & Co., who were large importers of the article, and who agreed to pay for the English and American patents and erect a mill for the manufacture of the fabric. Feeling assured that he would now be able to take a college course, he resumed his studies under a tutor; but Messrs. Freeman, Cobb & Co. failed in business, during a period of business depression, and it was difficult to raise money for new ventures. Moreover, his father had been unsuccessful in business and was now in declining health, and it was necessary that he should abandon all thought of college.

Having accidentally seen the process of weaving coach lace by hand loom, the idea of a power loom occurred to him. First ascertaining the demand for the article in question, he set himself to the production of a machine which had up to that time been deemed impracticable, and within six weeks of the time of its conception he had the loom in successful operation. This beautiful and complicated piece of mechanism involved all the essential principles of a more important one—the Brussels carpet loom—and its complete success brought the inventor at once into notice. Fairbanks, Loring & Co., of Boston; John Wright, of Worcester; Israel Langley, of Shirley, with Erastus B. Bigelow and Horatio Bigelow, formed a company for the purpose of building and running the looms, and were later incorporated as the Clinton Company. The Freeman, Cobb Co., having recovered from their financial embarrassments, were now desirous of contracting with Mr. Bigelow for a number of looms for the weaving of counterpanes; but a new fabric having entered the market from England, Mr. Bigelow set about the invention of a power loom for the invention of this new kind of counterpane. Within six months it was in successful operation, and a small mill in Lancaster was filled with the machinery. This business of weaving spreads has been steadily prosperous and has grown to large proportions.

Mr. Bigelow now took up the difficult problem of weaving ingrain or Kidderminster carpet by power looms, and he mastered this problem as he had mastered others. His first loom for two-ply ingrain carpets was set up within the year, and in matching of figures and evenness of surface surpassed the hand loom. Its average production was twelve yards per diem. A second loom produced eighteen yards. Still unsatisfied, he produced a third machine with essential variations which produced from twenty-five to twenty-seven yards a day. This loom was set to work in 1841. In the autumn of that year, he visited England and brought back many suggestions of practical value, so that the several manufacturing corporations of Lowell, in 1842, created a new office with a liberal salary and appointed him to fill it, his duties being to advise and suggest improvements in consultation with the agents of the respective companies. This brought forth some important changes, which were adopted by all the cotton companies of Lowell. Other interests absorbed his time so fully that he resigned this

charge at the end of a year and a half and the office dropped out of existence.

During that period he had built a mill for the Lowell Company to operate his power loom; and thus started the first successful power loom carpet factory noted in the annals of manufacture.

In 1842-3 Mr. Bigelow projected a new mill at Lancaster for the weaving of ginghams. Its buildings covered four acres of ground and were filled with machinery of the most perfect character, much of which was invented, and all of which was adjusted by Mr. Bigelow. The Merchants' Magazine of that period thus wrote of the establishment: "It is deservedly rated as the most perfect establishment in the United States." During the three years he was thus occupied, he made nine distinct important inventions, all of which were patented and put in operation. He now paid another visit to Europe, and on his return in 1848 proceeded to develop and perfect the Brussels carpet power loom, which he varied so as to produce also Wilton tapestry and velvet tapestry carpets. Specimens of his carpet were shown at the Exhibition in London, England, in 1851, but were put in too late to receive a prize, though full justice was done to Mr. Bigelow as the prior inventor of a successful power loom for the weaving of carpets, and his productions were pronounced more perfect than that of any hand loom. Messrs. Crossley & Sons immediately made an arrangement for placing the looms in their immense manufactory at Halifax, England, and they ultimately bought the patent rights for the United Kingdom. Over fifty patents were taken out by Mr. Bigelow for his various inventions.

Mr. Bigelow was elected a member of the Boston Historical Society in 1864, and in 1869 he made a presentation to that society of six volumes, entitled "Inventions of Erastus Brigham Bigelow, patented in England from 1837 to 1868," in which were collected the printed specifications of eighteen patents granted to him in England. Later in life, he made a study of the tariff and of taxation in general, and published various articles bearing on those questions. In 1862 he prepared a scheme of universal taxation throughout the United States by means of stamps; and in 1863 published a brochure entitled "The Tariff Question, Considered in Regard to England and the other Interests of the United States."

Mr. Bigelow's published writings mostly treat of political economy, in a manner very characteristic of his analytical skill, being precise in statement and clear in style. He contributed to the press in 1852, "Remarks on the Depressed Condition of Manufactures in Massachusetts, with Suggestions as to its Cause and Remedy;" in 1862 a large quarto entitled, "The Tariff Question Considered in Regard to the Policy of England and the Interest of the United States;" in 1869 an address, "The Wool Industry of the United States;" in 1877, "The Tariff Policy of England and the

United States Contrasted;" in 1878, "The Relations of Labor and Capital," an article in the Atlantic Monthly.

In politics he was generally conservative, never an active partisan, and in later life he proclaimed his independence of party. He was in 1860 nominated by the Democrats of the Fourth District as their candidate for Representative to Congress, but his opponent, Alexander H. Rice, secured the election by a small plurality.

He was one of the founders of the National Association of Wool Manufacturers and its first president, a member of the American Academy of Sciences, the Massachusetts Historical Society, and the London Society for the Encouragement of the Arts, Manufactures and Commerce. He was one of the founders of the Massachusetts Institute of Technology.

'About ten years before his death he bought an estate at North Conway, N. H., to which he gave the name of Stonehurst. He married, first, Susan W. King, who died in 1841, leaving an infant son who survived her for six years; second, Eliza Frances, a daughter of Colonel David Means, of Amherst, N. H., by whom he had one daughter, Helen, who was married to Rev. Dr. Daniel Merriman, pastor of the Central Congregational Church, Worcester, Mass.

Mr. Bigelow died in Boston, Mass., December 6, 1899.

HORATIO NELSON BIGELOW.

Horatio Nelson Bigelow was born at West Boylston, Mass., September 13, 1812. He was the son of Ephraim and Mary (Brigham) Bigelow, and grandson of Abel Brigham. His father, a farmer and wheelwright, was in very moderate circumstances, but his mother, "Polly" Brigham, was a woman of marked character and native dignity. The boyhood of Horatio Bigelow, as of his more widely celebrated brother, Erastus, was one of toil, and his educational opportunities were few; two years at the Bradford Academy completing them. He worked upon the farm and in the neighboring mills, and at the age of twenty had so far mastered the technical details of cotton manufacture that in 1832, when his father started a small factory on the Nashua, he became its overseer. In 1834 he was made overseer of the Beaman Mill, and in 1836 he was called to Shirley as general superintendent of a cotton factory there.

About 1837 he removed to Clintonville. Having a small capital, in company with his brother Erastus, he leased the vacant buildings and water power of the defunct Lancaster Cotton Company, and in March, 1838, the Clinton Company was incorporated by John Wright, H. N. Bigelow and Israel Longley. Horatio Bigelow was the general manager from

the inception of the business, being relieved during the years 1849-50-51 by C. W. Blanchard.

From the time of his settling at Clinton, H. N. Bigelow occupied a house known as the Plant Mansion, and he was the master-spirit in the enterprise of building up the new town socially as well as industrially. Though his load of responsibility was exceptionally heavy in the establishing of various new and untried manufactures, he found time to prove his solicitude for the future comeliness and prosperity of the busy town, which owes a large debt of gratitude to his fostering care.

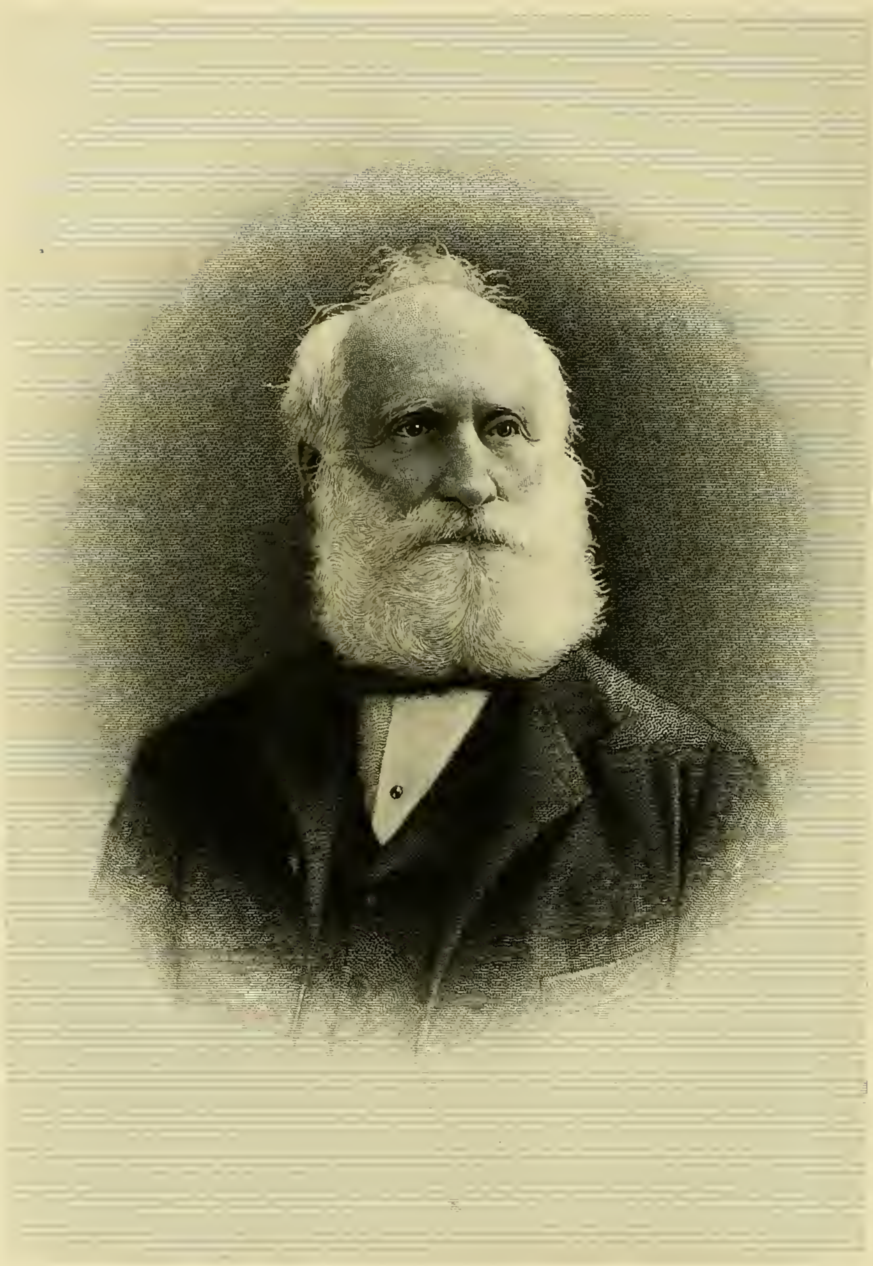
His energy hastened the forming of the first church society and the building of a little chapel for its use in the grove adjacent to his residence. He was himself an Orthodox Congregationalist, but he gave generously both support and money to other denominations. He urged the building of commodious schoolhouses and a radical improvement in the local school system.

H. N. Bigelow, in addition to filling the office of general manager of the various enterprises undertaken by his brother and himself, accepted various public trusts, which he performed with unswerving integrity and diligence. He was the first postmaster of the village and represented the town at the general court during the first two years of its corporate existence. He was the first president of the Savings Bank, vice-president of the First National Bank, a director of the Worcester and Nashua Railroad Company, the City Bank, and the Mechanics' Mutual Insurance Company of Worcester.

Mr. Bigelow married, September 4, 1834, Miss Emily Worcester, and had four children, two of whom died young. His widow survived him for many years, and his two sons, Henry H. and Charles B. Bigelow, inherited their father's administrative capacity and succeeded him as managing agents of the Bigelow Carpet Co. After three years of invalidism, Mr. Bigelow died at his home in Worcester, January 2, 1868.

HENRY PARKER FAIRBANKS.

Henry Parker Fairbanks was born in Boston, Mass., Sept. 7, 1808. He was a son of Stephen and Abby (Parker) Fairbanks, a grandson of Israel and Anna (Buckman) Fairbanks, great-grandson of Israel and Elizabeth (Whiting) Fairbanks, and descended through Joseph and Abigail (Deane) Fairbanks, Joseph and Dorcas Fairbanks, John and Sarah (Fiske) Fairbanks, from Jonathan and Grace (Lee) Fairbanks, of Medford, Mass. This Jonathan came to Boston from England in 1633, and



Frederick Ayer

later settled in Dedham, being one of the earliest pioneers, and was one of the signers of the covenant when the town was established and named.

Henry P. Fairbanks attended the Boston schools, where he acquired the distinction of being a Franklin Medal scholar. Mr. Fairbanks was a hardware saddlery merchant in Boston, but resided in Charlestown. In 1849 he became associated with Erastus B. and Horatio N. Bigelow as a partner in the firm of H. N. & E. B. Bigelow, who began the manufacture of carpets in Clinton, Mass., and was selling agent of that company up to the time of his death in 1854.

A Whig in politics, Mr. Fairbanks was an earnest, active worker for his party, and was a member of the State Legislature in 1847 as a representative from Charlestown; he was a member of Governor Clifford's Council in 1853. He was also a member of the city government of Charlestown from its organization in 1847, and for five years previous to his death was president of the Common Council. He was a member of the Massachusetts Charitable Mechanics' Association, a member of the Harvard Church, member of the Standing Committee from 1841 till his death, at which time he was also president of the Charlestown Lyceum, an institution in which he took a deep interest.

He married Mary Hurd Skinner, August 7, 1832, and had nine children, five of whom survived him. His son, Charles Francis Fairbanks, became treasurer of the Bigelow Carpet Company.

Mr. Fairbanks died of scarlet fever, February 14, 1854, at the early age of forty-five.

FREDERICK AYER.

Frederick Ayer was born in Ledyard, Connecticut, Dec. 8, 1822; son of Frederick and Persis (Cook) Ayer. (See sketch of James Cook Ayer, *Ibid.*) He was brought up in Ledyard, Conn., where he attended school and also a private academy in Baldwinsville, New York, and in 1839 became a clerk in the store of John T. Tomlinson & Co., Baldwinsville, N. Y., and in 1842 was admitted to partnership in another store of John T. Tomlinson & Co., in Syracuse. In 1845 he formed a partnership with the Hon. Dennis McCarthy, of Syracuse, N. Y., as McCarthy & Ayer, and remained in business in Syracuse, N. Y., up to 1855, when he removed to Lowell, Mass., to become a partner in the drug and proprietary medicine business of J. C. Ayer, the firm becoming J. C. Ayer & Co., of which his brother, Dr. James Cook Ayer, was the head. In 1877 the business was incorporated as the J. C. Ayer Company, and he was made treasurer of the corporation, holding that office up to 1893, when he resigned to give his entire time to his growing financial interests, including the cotton manufacturing business at Lowell and Lawrence.

He had, in conjunction with his brother, Dr. James C. Ayer, purchased the controlling interests in the Tremont Mills and Suffolk Manufacturing Company, of Lowell, Mass., in 1871, and consolidated the two companies as the Tremont & Suffolk Mills, and in June, 1885, he purchased at auction the Washington Mills at Lawrence, Mass. These mills had been known as the Bay State Mills up to the panic of 1857, and were celebrated for their product of "Bay State" shawls. Under Frederick Ayer's management, as president, one year, and as treasurer the mills were pronounced "the most perfect wool factory in the world," and were already known as the first to embark in the manufacture of all-wool fabrics, known as cashmeres, in America, in the manufacture of which the French had achieved such marvellous results. He was at one time president of the Portage Lake Canal, and for many years its treasurer, and he was also connected with the Lake Superior Ship Railway & Iron Company as a director, and for several years as both treasurer and secretary. In his home city, Lowell, he served as a director of the Old Lowell National Bank, Merchants' National Bank, as vice-president of the Central Savings Bank and as a director of the New England Telephone Company from its organization. He was one of the organizers, and for several years the treasurer of the Lake Superior Ship Canal Railway & Iron Company, and was one of its directors until it was merged into the Keweenaw Association. He served on the board of aldermen of the city in 1871, was chairman of the Board of Health, and in that office was credited with having been instrumental in checking and eradicating an epidemic of small pox in the city. In 1906 Mr. Ayer was a director and vice-president of the American Woolen Company (New Jersey), director and president of the American Woolen Company of New York, trustee and vice-president of the Central Savings Bank of Lowell, Mass.; director and president of the Lowell & Andover Railroad, director and president of the J. C. Ayer Company, and director of the Tremont and Suffolk Mills, Lowell, Mass., of the United States Mining Company, of the International Trust Company, of the Boston Elevated Railway Company, and of the Columbian National Life Insurance Company. He was a member of the Algonquin Club, Beacon Society and Country Clubs, of Boston.

He married in 1858 at Syracuse, N. Y., Miss Cornelia Wheaton. She died in 1878. Children of this marriage were: Ellen W., James C., Charles F., and Louise R. He married again at St. Paul, Minn., Miss Ellen Banning. The children of this marriage were three: Beatrice B., Katharine and Frederick, Jr.

J. C. Ayer

JACOB ROGERS.

Jacob Rogers was born in Exeter, N. H. He was the son of Col. John and Mary Poor (Cram) Rogers, and grandson of Judge Nathaniel Rogers. Colonel John Rogers was a graduate of Phillips Exeter Academy, cashier of the Old Exeter Bank from 1808 to 1830, a colonel of the Fourth Regiment of militia, and chairman of the Board of Selectmen from 1817 to 1831 and was prominently connected with the leather industry.

The subject of this sketch, Jacob Rogers, was educated at Phillips Exeter Academy, after which he spent several years at sea in long voyages to India and China. He settled in Lowell when about twenty, where he was connected with his brother, John, in the hardware business. There he remained until 1875, when he became president of the Railroad National Bank of Lowell, retiring from the presidency several years before the bank was merged with the other Lowell banks, but still serving as a director. He was treasurer of the Lowell Gaslight Company from 1870, when he was elected president, an office from which he retired in 1903. He was also a director of the Stony Brook Railroad from 1875. Mr. Rogers was president of the Kitson Machine Company from 1885 to 1905, when the property was sold to the Lowell Machine Shop. In 1901 he was elected president of the Tremont & Suffolk Mills of Lowell, of which he had long been a director. He was also a director of various Lowell corporations, including the Appleton Company, Massachusetts Cotton Mills in Georgia, Merrimack Manufacturing Co., of the Traders' & Mechanics' Insurance Co., a director of the Hide & Leather Bank until that institution was merged in the State National Bank of Boston, and vice-president of the Mechanics' Savings Bank of Lowell, Mass.

With Frederick F. Ayer he served as trustee of the estate of Dr. J. C. Ayer for many years. In politics he was a staunch Republican, and in 1864-5 he was elected to the House of Representatives. In 1875 he was elected a member of the Lowell Board of Aldermen. He married in 1868 Mary Howard, daughter of James G. Carney, of Lowell, and had three children: Mary Carney, Alice Poor and John Jacob.

JAMES COOK AYER.

James Cook Ayer was born in Ledyard, Conn., May 5, 1818; son of Frederick and Persis (Cook) Ayer, grandson of Elisha and Hope (Fanning) Ayer and of James and Persis (Herrick) Cook, and a descendant from John Ayer, who settled at Haverhill, Mass., early in the history of the colony. Elisha Ayer (1757-1853) was a soldier in the war of the

Revolution. Frederick Ayer (1792-1825), who participated in the War of 1812, was a manufacturer of woolen and cotton goods, being a pioneer in these industries in New England. James Cook Ayer spent his early life in Preston, Conn., and Lowell, Mass. He was educated at Lowell High School and Westford (Mass.) Academy and at the University of Pennsylvania, where he took his degree as M.D., 1839. He began his business life as a druggist and manufacturer of proprietary medicines in Lowell, Mass., in 1840, using the name of Ayer on all the products from his laboratory and advertising them extensively; being in reality the pioneer in effective advertising in newspapers and by means of almanacs that would be read in the household and preserved for future reference, in which he spent hundreds of thousands of dollars. He acquired a business in which he accumulated millions, and in 1877 this business was incorporated as the J. C. Ayer Company. In 1870 he became treasurer of the Tremont and of the Suffolk Manufacturing Companies, with mills at Lowell, and at the time separate corporations, and he helped to effect the consolidation of these two interests as the Tremont & Suffolk Mills, with a capital of $1,200,000, in 1871, when he was elected treasurer of the new corporation, resigning the position after a few months, but continuing as a director and large stockholder, as he had been in the separate corporations. He built the Lowell and Andover Railroad, which added greatly to the prosperity of the city of his adoption.

Mr. Ayer was married November 3, 1850, to Josephine Mellen, daughter of the Hon. Royal and Direxa (Claflin) Southwick, and their three children were: Frederick Fanning Ayer, Henry Southwick Ayer and Lesley Josephine Ayer. Mr. Ayer erected a beautiful home in Pawtucket Street, Lowell, and in 1892 his widow, then a resident of Paris, France, and his son, Frederick F. Ayer, of New York City, presented the property to the "Home for Young Women and Children," then housed on John Street, and the institution founded in 1876-7 was carried on as "The Ayer Home for Young Women and Children."

Mr. Ayer was afflicted with brain trouble late in life, which caused his death, July 3, 1878.

RICHARD KITSON.

Richard Kitson was born in Cleckheaton, Yorkshire, England, in 1814; the son of John Kitson, a card clothing manufacturer. He received a fair education in the schools of his native place and then joined his father in the manufacture of cards for combing. He assisted his father in making and patenting a machine for the manufacture of needle-pointed card teeth, which revolutionized the manufacture of card clothing. The patent expired in 1849, and financial losses brought about by the dishonesty of

others placed both father and son in business straits. Consequently, when Francis Calvert, of Lowell, Mass., U. S. A., who at the time was visiting Cleckheaton for the purpose of examining the Kitson cards, proposed that Richard go back with him to Lowell with the view of establishing a card clothing business there, the young man accepted, and as a result had the honor of manufacturing the first needle-pointed card clothing in America. Mr Kitson next remodeled and thereby improved the picker then in use, and at the same time invented a single cotton-opening machine which came into universal use in the cotton mills throughout New England. Whitin and other inventors and manufacturers of lappers had used beaters up to the time Kitson introduced his needle-pointed cylinder. Through Mr. Kitson's inventive genius, the principle afterward applied in the "trunk system" for opening and cleaning cotton fibre was next introduced. Until 1860 all of his machines had been made by outside manufacturers, but the increasing demand prompted him to erect a shop wherein to manufacture these machines himself. This he did, and the business so prospered that, in 1874, it was incorporated under the style of the Kitson Machine Company, Mr. Kitson becoming president and holding office up to the time of his death. Mr. Kitson was a man of great mechanical genius, and to him the textile world owes much for the advancement made in the manufacture of machines for the manipulation of cotton.

While in England Mr. Kitson married Sarah Reynolds, who accompanied him to America. Six children were born of this union, one of whom, Emma, became the wife of Thomas Stott, a card clothing manufacturer of Lowell. Mr. Kitson was survived by his wife and two children, Charlotte and Mrs. Stott. He died in Lowell, Mass., July 14, 1885.

WILLIAM ALVORD BURKE.

William Alvord Burke was born in Windsor, Vt., July 7, 1811, the son of Benjamin and Roxana (Alcord) Burke, a grandson of Solomon Burke, one of the first settlers of Windsor, Vt., and a descendant of Richard and Mary (Parmenter) Burke, of Sudbury, Mass., who came to this country about the year 1660.

His early education was obtained in the public schools and at the Academy of Josiah Dunham at Windsor, Vt., where he very early exhibited unusual powers for the acquisition of knowledge and began the study of Latin at the early age of seven years. It was his ambition to pursue a collegiate education, but circumstances not favoring such a course, upon the removal of his parents to Nashua, N. H., at the age of fifteen he entered the machine shop of the Nashua Mfg. Co., where he worked for several

years, and also in the shops of the Locks and Canals in Lowell, Mass. (now the Lowell Machine Shop), up to January, 1834, when he was placed in charge of the machine shop of Ira Gay & Co., of North Chelmsford, Mass.; here he remained for two years. He was appointed Master Mechanic of the Boott Cotton Mills, of Lowell, Mass., in 1836, where he remained for three years, when further promotion awaited him in his selection as Master Mechanic of the newly erected machine shop of the Amoskeag Mfg. Co., of Manchester, N. H. He put into successful operation, and had charge of these works for six years. His position necessitated the designing and building of cotton machinery, which afterwards became a chief occupation of his life; as at this time it was impossible to obtain any machinery from England, he was, therefore, left to his own resources, or to the very few and crude drawings obtained elsewhere.

In 1845, the shops of the Locks and Canals in Lowell, Mass., were sold to a corporation, which later became known all over the world as the Lowell Machine Shop, and Mr. Burke was invited by those who knew his ability to take charge and develop the business. These works were then, and still remained for many years, the largest of their kind in the United States. In this charge Mr. Burke remained for seventeen years. During that time the shop made nearly every sort of machinery from a sewing-machine to a locomotive; but their principal business was then, as it became altogether later on, the building of cotton machinery. In 1862 he was elected agent of the Boott Cotton Mills, of Lowell, Mass., in which he had previously been master mechanic, where he remained for six years, his administration proving an eminent success. In 1868 he resigned, and was offered the treasurership of the Suffolk Manufacturing Company, and Tremont Mills (now known as the Tremont and Suffolk Mills) of Lowell. Here he remained for two years, but circumstances not proving congenial, he resigned and shortly afterwards was appointed assistant treasurer of the Great Falls Mfg. Co., of Somersworth, N. H., and the Dwight Mfg. Co., of Chicopee, Mass. Here also he remained for six years supervising the renovation and rebuilding of the mills, and placing them in a condition where they have since become among the most successful mills in the country.

In 1876, Mr. Burke received his last appointment, as treasurer of the Lowell Machine Shop, of which in his earlier years he had been the first superintendent. Here he remained until declining years advised him that his work as an active business man was over, and he resigned in 1885. During his treasurership, almost every building was remodeled and enlarged, some new ones were added and the working force was largely increased. Mr. Burke was frequently consulted on matters pertaining to cotton manufacturing, and he was director of many of the most successful cotton manufacturing corporations. He was one of the charter members of the New England Cotton Manufacturers' Association (now known as the

D. A. Brayton

National Association of Cotton Manufacturers) and one of its first vice-presidents, from 1865 to 1873. He was one of the original corporators of the Mechanics Savings Bank of Lowell, Mass., and its first president from June, 1861, to June, 1886, when he retired.

He took but little active part in politics, but served his city as alderman for two years during the Civil War.

Mr. Burke was twice married, first to Catherine French, of Bedford, N. H., by whom he had five children; and second to Elizabeth Mary Derby, who survived him, but died in February, 1900.

Mr. Burke died in Lowell, Mass., May 28, 1887, at the age of seventy-six years.

DAVID ANTHONY BRAYTON

David Anthony Brayton, prominent in the business and financial enterprises of Fall River, was born on the 2d of April, 1824, in the village of Swansea, Massachusetts, and died in London, England, on the 20th of August, 1881. He was the son of Israel and Kezia (Anthony) Brayton, and his ancestry includes many of the pioneers of Rhode Island and Massachusetts, men who were foremost in the annals of New England. His uncle, David Anthony, was the first agent of the Fall River Manufactory, one of the two original cotton mills built in Fall River (then called Troy), in 1813. He was also a relative of Dexter Wheeler, a promoter of this corporation, who had already spun yarn by horsepower in Rehoboth as early as 1807, and of Nathaniel Wheeler, one of the founders of the Troy Cotton and Woolen Manufactory, the other corporation organizing in 1813.

David A. Brayton, who received his name from his maternal grandfather, David Anthony, obtained the rudiments of a practical education in the schools of Fall River and Somerset, Massachusetts. The marked intelligence which he early displayed, combined with his diligence and close application, placed him in the front rank among his associates at school, and before reaching his majority he was well equipped for the active duties of life. While yet a minor he showed his aptitude for business, and began his independent efforts by shipping a cargo to Cuba, going there in the same vessel. In later years he carried on an extensive business with the West Indies, importing molasses and sugar in vessels, of which he was the principal owner.

In 1849 he became interested in the discovery of gold on the Pacific Coast, and sailed for California in the ship "Mary Mitchell" in August of that year. On returning to Fall River in 1850 he engaged in the manufacture of flour, with Silas Bullard as partner, and erected the Bristol

County Flour Mills, the first industry of its kind in this part of Massachusetts, of which he afterwards became the sole proprietor.

As its name indicates, the First National Bank of Fall River was the first in this section of Massachusetts established under the National Bank Act and was organized January 23, 1864. To David A. Brayton this institution owes its origin and to it he gave his valuable counsel, serving as a member of the Board of Directors from its organization until his death.

Mr. Brayton was an acknowledged leader of men, endowed with sterling integrity, clearness of intellect, and sound judgment; a man of diversified interests, with a comprehensive grasp of the details of every enterprise with which he was connected. He realized the great progress which had already been made in the cotton industry since its advent into Fall River in 1811; he readily foretold the possibilities of its future growth, and appreciated the advantages afforded by the extensive harbor and the natural water supply of the city. In 1865, just after the Civil War, confident of success in this undertaking, David A. Brayton, with his brother, John S. Brayton, and his nephew, Bradford M. C. Durfee, planned the erection of large cotton mills. A charter of incorporation was granted them on Feb. 15, 1866, under the name of Durfee Mills, so-called in honor of Bradford Durfee, whose son was the largest stockholder. Eleven acres of land were purchased, bordering upon the stream from which Fall River obtains its name, and the foundation of this manufactory was laid. As a result of the indefatigable energy and business ability of David A. Brayton, Durfee Mills Number One was completed and in full operation in 1867; in 1871 mill Number Two was built upon the same plan; in 1880 Durfee Mills Number Three, somewhat smaller than the others, was added, and these formed, at the time of their erection, the largest print cloth plant in a single enclosure in the country. He was Treasurer of this corporation from its organization until his death, and this group of granite buildings, with its commanding presence, is a lasting monument to the foresight, wisdom, and undaunted perseverance of David Anthony Brayton.

One of the greatest achievements of his life, possibly the greatest, next to the erection of the Durfee Mills, was the result of his investment in the Arnold Print Works, at North Adams, Massachusetts, in 1876, at a time when that corporation had gone into bankruptcy. This failure had caused great depression. Mills were closed, men were idle, and Mr. Brayton's purchase of this large plant was a lasting benefit and stimulus to the town of North Adams, giving confidence to its business enterprises and employment to its people. A new organization was formed with David A. Brayton as president (and largest stockholder), Albert C. Houghton as treasurer, William A. Gallup, clerk, and Caleb G. Evans, originator of designs and seller of goods. Several years later, at a dinner given by Mr. Gallup, who for twenty-five years had been connected with the Arnold

Print Works, the President of this corporation, Albert C. Houghton, paid the following tribute to the memory of Mr. Brayton: "Another name of even higher incentive to us is that of David A. Brayton, the restorer, as Mr. Arnold was the originator of the industry we represent. At the time of hardest trial, when friends were faint and foes were fierce, he took upon himself our jeopardy, and gave his capital and his business fame to our support. A man of calmest and most far-sighted judgment, upright, straightforward, of indomitable will, resistless energy and creative business intuition; the serene and chiseled features of that portrait are the fit outward presentment of the most remarkable business associate and leader the Arnold Print Works has had."

Mr. Brayton, at the time of his death, was director in several other corporations; namely, Fall River Iron Works Company, which at that time was devoted exclusively to the iron industry; the Metacomet Manufacturing Company, Fall River Machine Company, Fall River and Providence Steamboat Company, Fall River Gas Company and the Fall River Manufacturers' Mutual Insurance Company.

As a citizen Mr. Brayton was ever alert to the best interests of the city, supported every effort for the growth and prosperity of the community, and his successful career made an indelible impression upon the commercial development of Fall River.

He was an active member of the First Congregational Church, and prominent in the promotion of its work and welfare. He was unostentatious in his benevolence, and liberally assisted those worthy of his aid.

David A. Brayton was married in Fall River, May 1, 1851, to Nancy R. Jenckes, daughter of John and Nancy (Bellows) Jenckes. They had five children, Nannie Jenckes, David Anthony, John Jenckes, Elizabeth Hitchcock and Dana Dwight Brayton.

THOMAS JEFFERSON COOLIDGE.

Thomas Jefferson Coolidge was born in Boston, Mass., August 23, 1831; son of Joseph and Ellen Wayles (Randolph) Jefferson. His first ancestor in America, John Coolidge, came from England in 1630 and settled in that part of Massachusetts Bay Colony known as Watertown, which embraced all the territory on the borders of the Charles River beyond Newtowne (Cambridge). He was made a freeman of Watertown in 1636, and soon after acquired considerable property in Boston. His descendant in the seventh generation, Joseph Coolidge, was born in Boston, in 1798, and was graduated from Harvard College A. B. 1817 and A. M. 1820. Upon leaving college, he travelled in Europe, and while at Pisa he became ac-

quainted with Lord Byron, who in his journal of 1821 records an account of his friendship with the young American. Thomas Jefferson Coolidge, his fourth son, was named for his illustrious great-grandfather, the third President of the United States and author of the Declaration of Independence. He, with his brother, Sidney, was instructed at the best schools of Geneva and Dresden, and the boys remained in Europe for eight years.

In 1847, Thomas Jefferson Coolidge entered the sophomore class of Harvard College, was graduated A.B., 1850, and took his master degree in course. He had a decided preference for trade, his father being a china merchant, and on leaving college he secured a clerkship in the store of William Perkins, in Boston. In 1853 he left the employ of this gentleman to become a partner with Joseph P. Gardner in the East India trade, under the firm name of Gardner & Coolidge. Later he became interested in banking and manufacturing enterprises. In 1858 he was elected president of the Boott Cotton Mills Company, operating large mills at Lowell, and he rescued that corporation from financial straits, and placed it upon a prosperous and successful footing. He resided in France from 1865 to 1867, when he returned to Boston and became treasurer of the Lawrence Manufacturing Company, operating five mills at Lowell. He resigned this position in 1880 to assume the presidency of the Atchison, Topeka and Santa Fé Railroad, and it was again his mission to resuscitate a flagging industry. He piloted it through the period of depression, and, in 1882, when it was again upon a firm basis, he resigned. On returning to America from France, he temporarily assumed the presidency of the Oregon Railway and Navigation Company. He returned to the manufacturing business the next year, and became identified with large New England cotton manufactories, including the Armory, the Dwight and the Amoskeag Manufacturing Corporations, being treasurer of the latter for a time and president afterwards. He also served as a director in the Chicago, Burlington & Quincy Railroad, in the Boston & Lowell Railroad, and in numerous other railroad enterprises. He was a director in the Merchants' National Bank, of Boston, and the Old Colony Trust Company, and served as treasurer and manager in various philanthropic associations. Harvard Corporation elected him as overseer in 1886, and he was re-elected in 1891. He served the city of Boston as Park Commissioner, 1875 and 1876; was a delegate to the Pan-American Congress in 1889; was appointed, April 28, 1892, by President Harrison, U. S. Minister to France as successor to Hon. Whitelaw Reid, resigned; and he served up to the close of Mr. Harrison's administration in 1893. He was a member of the Anglo-American Commission which met at Quebec, Aug. 25, 1898.

Mr. Coolidge gave to the village of Manchester-by-the-sea, the location of his summer residence, a public library building costing $40,000, and to Harvard University he gave, in 1884, the Jefferson Physical Laboratory, which building was erected at a cost of $115,000. He received the honorary

Wm. W. Crapo

degree of LL.D. from Harvard in 1902. He was a member of the Somerset Club, of Boston, and the Harvard and University Clubs, of New York, and he gave generously to the various public charities of Boston.

Mr. Coolidge married, in 1852, Hetty S., daughter of the Hon. William (1786-1862) and Mary Anne (Cutler) Appleton, and a descendant from the emigrant ancestor, Samuel Appleton (1586-1670), who came from Little Waldinfield, England, in 1635, was made a freeman in Ipswich, Mass. Bay Colony, May 25, 1636, and was deputy to the General Court in 1637. Their son, T. Jefferson, Jr., became president of the Old Colony Trust Company, and their three daughters married Mr. Lucius Sargent, Mr. Frederick Sears, Jr., and Mr. Thomas Newbold.

WILLIAM WALLACE CRAPO.

William Wallace Crapo was born in Dartmouth, Mass., May 16, 1830; son of Hon. Henry Howland and Mary Ann (Slocum) Crapo, and a descendant of Peter Crapo, who married Penelope White, May 31, 1704. Henry Howland Crapo was also a native of Dartmouth, born of parents who were in humble circumstances, and, self-taught, he became a surveyor and a school teacher, removed to New Bedford, where he held the offices of town clerk, treasurer and collector of taxes for nearly twenty years. In 1857 he removed to Flint, Michigan; in 1862 was elected mayor of that city, served for two years as state senator, and in 1864 was elected governor of the state and held that office for four years.

William Wallace Crapo was the only son in a family of ten children. He acquired his preliminary education in the public schools of New Bedford and at the Friends' Academy; was fitted for college at Phillips Academy, Andover, and was graduated from Yale in the class of 1852. He decided to make the law his profession, attended the Dane Law School at Harvard, and studied law in the office of the Hon. John Clifford, of New Bedford. February, 1855, he was admitted to the Bristol bar; April, 1855, he was elected city solicitor of New Bedford, and held that office for twelve consecutive years. He followed the practice of his profession in New Bedford; alone, 1855-62; as senior of the firm of Crapo & Stone, 1862-69; as a member of the firm of Marston & Crapo, 1869-78, and as senior member of the firm of Crapo, Clifford & Clifford, from 1878.

In 1856 he entered the political field, making his maiden speech in behalf of John C. Fremont, the first candidate of the Republican Party for President, and later in the same year he was elected to the Massachusetts House of Representatives. In 1857 he was strongly urged to accept nomination as the Republican candidate for State Senator of his district, but his

pressing professional duties compelled him to decline the honor. He rapidly advanced to a notable prominence in his profession, in which he acquired a high reputation. He was actively interested in the growth and prosperity of the city of New Bedford, was a prominent factor in the establishment of its water works, and from 1865 to 1875 was chairman of the Board of Water Commissioners.

During the Civil War he heartily supported the government, and during the whole period of its duration gave freely of his time, energy and means to the Northern cause.

Mr. Crapo's interest in cotton manufacturing began with his investments in the Wamsutta Mills in 1846. Later he was chosen a director of that corporation, and, in 1889, was chosen to succeed Andrew G. Pierce as its president, and has served in that capacity up to present time (1911). In 1892 he acquired an interest in the Potomska Mills, in 1882 in the Acushnet, and in 1893 in the Hathaway Mills, all of New Bedford, and served on the directorate of each of these corporations, and also as president of the Potomska Mills (1911).

Mr. Crapo's deservedly high reputation as a man of weight and ability rests pre-eminently upon the services he rendered his party and the people at large in the National House of Representatives. Being elected to fill a vacancy in the Forty-fourth Congress, he was re-elected to the three succeeding Congresses and declined renomination in 1882. He was a member of the Committee on Foreign Affairs in the Forty-fifth Congress, and a member of the Committee on Banking and Currency in the Forty-sixth; as chairman of the same committee in the following Congress, he rendered valuable service in obtaining the passage of the bill for extending the charters of the national banks, to which there was great and determined opposition. He was also influential in obtaining the removal of the tax on the capital and deposits of banks and bankers and in securing the direct application of the law to the national banks. He bore a conspicuous part in various other legislative measures of importance, and the purity and integrity of his motives and conduct in both public and private affairs was conceded by all. He was several times mentioned as a possible candidate for gubernatorial honors, and his failure to receive nomination is attributed largely to his aversion to the employment of the ordinary political methods of the day. Mr. Crapo was an active champion of the New Bedford fishing interests, and strongly recommended the abrogation of the fishing articles of the treaty of Washington. He was an elector-at-large from Massachusetts on the Republican National ticket in 1904, and in the Electoral College that met in 1905 he cast the vote of the Massachusetts electors for Theodore Roosevelt as President of the United States. From the outset of his career he was called upon to fill many positions of trust which demanded the exhibition of those qualities of sagacity, prudence and good judgment which he possessed in such large measure. He was guardian

and trustee of many estates, president of the Mechanics' National Bank, of New Bedford, from 1870 to 1904; he became a director of the International Trust Company, of Boston, in 1883, and was for some years a vice-president of that institution, his successor being Frederick Ayer. Has been president of the New Bedford Institution for Savings since 1896. He was also President of the Flint and Père Marquette Railroad Company.

A diligent student of the early history of the colony, he made many valuable contributions to the historical literature of his state, especially in regard to Dartmouth, and delivered a masterly address on the occasion of the centennial celebration of that town in 1864.

Yale University conferred upon him the honorary degree of LL.D. in 1882. He was a member of the Massachusetts Historical Society, and served as president of the Old Dartmouth Society.

Jan. 22, 1857, Mr. Crapo married Sarah Davis, daughter of George and Serena (Davis) Tappan, of Newburyport. Arthur Tappan (1786-1865), the educationalist and anti-slavery agitator, Benj. Tappan (1773-1857), U. S. Judge and U. S. Senator for Ohio, and Henry Philip Tappan (1805-81) president of the University of Michigan, were all of this same Tappan family. The children of William W. and Sarah Davis (Tappan) Crapo were: Henry Howland and Sanford Tappan, who became general manager of the Flint and Père Marquette Railroad.

JOHN HOWARD NICHOLS.

John Howard Nichols was born in Kingston, N. H., December 18, 1837, son of Nicholas and Mary (Barstow) Nichols. His early life was spent in his native town and in Exeter, N. H., where he attended the Phillips Academy. On completion of his course he taught school for one year at Stratham, N. H. When eighteen years of age, he came to Boston and engaged as clerk with a tea importing house on Central Wharf. Here he came under the notice of John L. Gardner, who recognized his sterling qualities, and in 1858 engaged the youth as supercargo on the bark "Arthur," which was about to sail around the Cape to China. Some four months later, upon Mr. Nichols' arrival in that country, he received a letter from Mr. Gardner requesting that he remain in China as special agent for the house. Mr. Nichols accepted and spent ten years in all in the East, returning to visit America once during that time. He was the first merchant to import tea to America from the Island of Formosa, following up the opening of the various ports of Japan with successive visits to the Empire and studying the possible effects of the new market on American trade. He resigned his position of Eastern representative in

1868, and returned to America, devoting his attention to the importing of Japanese and Chinese teas. In January, 1876, he disassociated himself from this business to accept the treasurership of the Dwight Manufacturing Co., Chicopee, Mass. Under Mr. Nichols' management this corporation became one of the most profitable textile manufactories in New England. Mr. Nichols established a branch cotton mill at Alabama City, Alabama, and through this means added greatly to the earnings of the corporation. During his twenty-nine years of management the capacity of the mills was increased from 120,000 to 200,000 spindles; dividends to the amount of $3,324,000 were paid, and a debt of $300,000 on the plant gave place to a surplus equal to the amount of the capital stock. In July, 1905, Mr. Nichols resigned as treasurer to become president, filling this place until his death in September of the same year. In 1886, upon the urgent request of some of his associates, Mr. Nichols became treasurer of the Great Falls Manufacturing Company, and the same success which marked his management of the Dwight Manufacturing Co. was achieved with the Great Falls Mfg. Co.; during the fourteen years Mr. Nichols was treasurer the plant was rehabilitated and the surplus largely increased, in addition to substantial dividends paid out during this period. At the time of his death, Mr. Nichols was also president of the Manchester Mills, Manchester, N. H., and the Lyman Mills, Holyoke, Mass.

In memory of his son, Howard Gardner, who after graduating from Harvard in 1892 took charge of the erection of the Alabama mills of the Dwight Manufacturing Co., and through the co-operation of his father created the model mill village in Alabama, and who met with a fatal accident while engaged in the performance of his duties, Mr. Nichols erected at Alabama City a Public Library Building. He gave to the Hale Hospital, Haverhill, Mass., when that edifice was rebuilt in 1900, the administration building, also in memory of his son; and erected and dedicated to the memory of his father and mother a public library in his native village, Kingston, N. H.

March 15, 1870, Mr. Nichols married Charlotte Peabody, daughter of Daniel and Charlotte (Tenney) Kimball, a descendant of Richard Kimball (1595-1675), who immigrated from Ipswich, England. Four children were born of this union, one son, Howard Gardner, and three daughters: Eleanor, who married Dr. Henry O. Marcey, Jr.; Grace; and Charlotte, who married Edwin Farnham Greene, treasurer of the Pacific Mills.

Mr. Nichols died at his home in Newton Mass., September 15, 1905, being survived by his widow and three daughters.

Stephen Greene

STEPHEN GREENE.

Stephen Greene was born at Hope, Rhode Island, September 27, 1851, the second son of Alvin and Maria (Arnold) Greene. In October, 1856, the family removed to Yarmouth, Maine, where they remained until January, 1859. They then returned to Rhode Island, Mr. Greene engaging as superintendent of a brick cotton mill in White Rock, owned by Messrs. Babcock & Morse. The subject of this sketch, while in Maine, had attended school a portion of the time, and on returning to Rhode Island continued with his elementary studies in the district school. When he was twelve years of age, he built the fires, cared for the schoolhouse and assisted in teaching the lower classes. He next attended the Westerly High School, and upon graduation, having at various times worked under his father in cotton mills, he was engaged by Babcock & Morse as "doffer" and "spare hand." He soon aspired to a life higher than that of a mill-hand, and his close attention to duty won him promotion as "second-hand" of the spooling-room and dressing-room. He also watched the mill at noon and rang the bell to call the operatives from dinner. In addition, he studied music and became a proficient player on the melodion and church organ. When sixteen years old, he was made overseer of the carding room. In the autumn of 1870, with his brother Benjamin, he visited New York, and while there obtained a phrenological chart which greatly influenced his determination to take up the business of civil engineering. He subsequently entered Brown University, his examination admitting him to the second year's class in the civil engineering course, and he was graduated B. P. with the rank of Phi Beta Kappa, 1873. The same year he began work in the office of N. B. Schubarth, architect and engineer of Providence. He was married Dec. 15, 1874, to Natalie L., daughter of his employer.

In April, 1875, Mr. Greene accepted a position in the office of D. M. Thompson & Co., mill architects and engineers, and the same year he became superintendent of construction of the Hills Grove Mills, erected by Thomas J. Hill. At Hills Grove was born his first son, Edwin Farnham Greene. In November, 1879, he returned to Providence, to take a position in the office of A. D. Lockwood & Co., Mr. Lockwood being recognized as the successor to David Whitman, deceased, as the leading mill engineer of New England. In Providence, his son, Stephen Harold, was born April 27, 1880, and Everett Arnold, May 14, 1885. On March 1, 1882, Stephen Greene became a member of the firm of Lockwood, Greene & Co., of Providence, the members of the firm being Amos D. Lockwood, J. W. Danielson, and Stephen Greene. During the first year of this partnership, he made an extended tour through the Southern States, and with so magnetic a pusher in the field, the business of the firm rapidly increased. In the spring of 1884 Mr. Lockwood died, and while his son-in-law, Mr. Danielson, the other partner, continued in the firm as advisor, the business

was virtually in the hands of the young mill engineer. He was at this time instrumental in organizing, on the foundation of the Ocean Mill property at Newburyport, Mass., the Whitefield Mills, with Seth M. Milliken as a principal stockholder, and in November, 1886, he removed his family to Newburyport and took an active part in the organization and operation of the new mill as treasurer, and also continued an engineering office through which he could keep in touch with the great manufacturing world, of which he had already become a prominent factor. The Whitefield Mills venture was not financially successful, and he determined to remove the machinery to the South, and take advantage of the proximity of the mill to the cotton fields and cheap labor. This was the pioneer movement of transporting an entire Northern cotton mill to Southern soil, and the prosperous Spartan Mill of Spartanburg, S. C., was the result. He removed his engineering office to Boston in January, 1890, and became a middleman between the two sections, and Lockwood, Greene & Co. built most of the large mills in the South and added two million spindles to that section, or one-third of the spindle capacity of the entire South. The firm also reorganized the mills of the Pepperell Mfg. Co., the Chicopee Mfg. Co., and the Androscoggin Mills.

Mr. Greene was a director of many of the largest and most successful mills in the South and North and a director of several of the insurance companies. He designed the plants of the Crompton & Knowles Loom Works, the Plymouth Cordage Co., the Saco & Pettee Machine Shops, the Atlas Tack Company's factory, Ginn & Company's Publishing Plant, the American Optical Company's buildings, and many other prominent plants. After 1890 he resided in Newton Centre, where, in 1893, another child, Frederick Hartwell, was born. Mr. Greene died in Newton Centre, Nov. 7, 1901.

EDWIN FARNHAM GREENE.

Edwin Farnham Greene was born in Hills Grove, a suburb of Providence, Rhode Island, February 9, 1879, the eldest son of Stephen and Natalie L. (Schubarth) Greene and grandson of Alvin and Maria (Arnold) Greene, and Niles B. and Elizabeth C. (Reed) Schubarth. (See sketch of Stephen Greene, *Ibid.*) Until November, 1886, the subject of this sketch lived in Providence, R. I. He then removed with his family to Newburyport, Mass., his father having been instrumental in organizing the Whitefield Mills of that city. Edwin Farnham Greene attended the public schools in both his native town and Newburyport, and then became a pupil at the Worcester Academy, being graduated in 1897. Subsequently, he entered Brown University, and completing his course, received

Thos Goodall

the degree of A. B., in 1901. November 7, 1901, his father died, and in the beginning of the following year Edwin Farnham Greene was elected to succeed him as president and member of the firm of Lockwood, Greene & Co., a position which he still holds (1911). From July, 1905, to December, 1907, he served as treasurer of the Dwight Manufacturing Company, and in October, 1906, accepted the office of treasurer of the Lawton Mills Corporation. This position he resigned in March, 1908, having the previous November been elected to the treasurership of the Pacific Mills.

Other offices held by Mr. Green in 1911 were: director of National Shawmut Bank; Old Colony Trust Co.; Boston & Maine Railroad; Nyanza Mills; Boston Mfrs. Mutual Fire Insurance Co.; American Mutual Liability Insurance Co.; Dwight Mfg. Co.; Great Falls Mfg. Co.; Lawton Mills Corporation; The Dallas Mfg. Co.; Colonial Securities Co., trustee of Worcester Academy and Brown University.

June 20, 1903, Mr. Greene married Charlotte, daughter of J. Howard and Charlotte Peabody (Kimball) Nichols, and in 1910 had two children, John Gardner, born October 28, 1904, and Edwin Farnham Greene, Jr., born July 14, 1910.

THOMAS GOODALL.

Thomas Goodall was born in the town of Dewsbury, Yorkshire, England, September 1, 1823, son of George and Tabitha Armitage Goodall. The subject of this sketch was left an orphan when a mere infant, and at a very early age was placed in a woolen mill as an apprentice, where he remained for eleven years; by 1840, being then seventeen years old, he had mastered the details of the business and had charge of the buying of materials and the disposing of the product. When he became of age, he started out to work for himself with all of his belongings tied up in a bundle and only five shillings in his pocket. In 1844 he set up in business for himself and met with a fair degree of success.

In 1846 he came to the United States, resided for a brief time in Connecticut and then removed to South Hadley, Mass., where he obtained a good position which he later resigned in favor of a needy countryman with a large family, and went to Rhode Island, where he remained nearly two years. He then returned for a short time to South Hadley, but in 1849, he went to West Winchester, N. H. Finding the business opportunities of that place inadequate to his ambition, he removed in 1852 to Troy, N. H., where he engaged in the manufacture of satinets and beavers, to which he added the manufacture of horse blankets, of which he was the pioneer in this country, being the first to manufacture shaped horse blankets

and put them up fifty in a bale. He presented many bales of blankets for the soldiers of the Union in the Civil War and also for the Navy.

In 1865 he sold his plant to a syndicate of Keene, N. H., manufacturers, who have carried on the work to the present day. Mr. Goodall then paid an extended visit to his native land, and while there engaged in the exportation of lap-robes manufactured expressly for the United States and Canada.

He made numerous trips to the United States on business, and at length determined to establish a factory for the production of the goods he had been exporting from England, and purchased in 1867 from William Miller and James O. Clark, of Sanford, Me., a flannel factory and grist and saw-mill, with the entire water privilege of the Mousam controlled by them at this point, and early in the following year had two sets of cards and ten looms in operation, with fifty operatives producing carriage robes and kersey blankets. The Sanford Mills now employ about 1,500 operatives, and the growth of the Goodall enterprises which had their inception in this first venture of Thomas Goodall have converted the rustic farming village of Sanford into an important commercial centre.

In 1884, Mr. Goodall resigned his position as president of the Sanford Mills Corporation. In 1895 he retired from business and relinquished his interest in favor of his sons, Louis B., George B., and Ernest M.

April 29, 1849, Mr. Goodall married Ruth, second daughter of Jerry Waterhouse, a leading manufacturer of South Hadley, Mass., and had five children, Louis Bertrand and George Benjamin (twins), Ernest Montrose, Ida May, and Lila Helen, the last two dying in infancy. Mr. Goodall died at Sanford, Me., May 11, 1910, his three sons surviving him.

CHARLES LEWIS HILDRETH.

Charles Lewis Hildreth was born October 9, 1823, in Concord, New Hampshire, being the son of Elijah and Isabella (Caldwell) Hildreth. The family of Hildreth is of English origin, some of its members coming to this country at a very early period. Richard, the common founder of the Hildreth family in the United States, was a pioneer settler in Massachusetts.

When the subject of this sketch was about three years old, the family moved to Nashua, N. H., where he attended Grace's private school until he entered Appleton Academy at New Ipswich, N. H. After completing his educational course, Mr. Hildreth went to Lowell, and, as an apprentice in iron working, for three years served at the Lowell Machine Shop, and then became a contractor in the same shop. During the business depres-

sion of 1858, he again made a change, removing to Philadelphia and entering the employ of the Industrial Works as foreman. In 1860, he returned to his former position at Lowell, and two years later was transferred to the draughting room. In 1865, he assumed the responsible duties of general foreman, and as such remained until 1879, when he was appointed superintendent. In 1905, he resigned this latter position, and went to live at Westford, Middlesex County, Mass.

In politics, Mr. Hildreth was a member of the Free Soil Party, but later became a staunch Republican, and served as an alderman from Ward 1 to the city of Lowell in 1868-69-70. July, 1846, Mr. Hildreth married at Nashua, N. H., Mary M. Lovejoy, daughter of Caleb Lovejoy, and two children were born to them, Emily Frances and Ella Francelia.

He died at Westford, Mass., February 26, 1909.

CRANMORE NESMITH WALLACE.

Cranmore N. Wallace was born in Braintree, Mass., November 6, 1844, son of William Vinson and Maria (Keene) Wallace. His father was of Scotch-Irish descent, while his mother's ancestors were English, of the early Plymouth Colony, and on both sides the great-grandfather was a Revolutionary soldier. Studying in the public schools of his native town until nearly eighteen years of age, the subject of this sketch then entered military service in behalf of the Union forces, serving as volunteer in four different army corps in the Department of North Carolina and the Army of the Potomac, and upon the expiration of his term of service he re-enlisted and remained until the close of the Civil War, and rose from the ranks to a staff officer. In 1865, Mr. Wallace was engaged as office clerk by the Boston Flax Mills of Braintree, Mass., predecessor of the Ludlow Mfg. Co. Associates. In 1884 he became the selling agent and was later made president of the company. During his connection with these mills, he was largely influential in their successful growth.

Mr. Wallace held various civil positions, being a member of the Massachusetts Legislature, in 1875, Water Commissioner and member of the School Committee. He became trustee of the Massachusetts Homeopathic Hospital and Massachusetts Soldiers' Home, and was a member of the New England Historic-Genealogical Society, Bostonian Society, and the Grand Army of the Republic, being Past Commander of Edward W. Kinsley Post 113. In 1889 he served as Quartermaster General of the Department of Massachusetts, member of the Executive Committee and chairman of the Sub-Committee, in 1890, when the National Meeting was held in Boston, member of the Executive Committee and chairman of the

Parade Committee and Assistant Adjutant General of the National Department of the United States, in 1904, at the time of the corps parade in Boston, member of the personal staff of Gen. A. R. Chaffee at the inauguration of President Roosevelt in 1905, member of the Boston Athletic Association, Algonquin Club, Eastern Yacht Club, Exchange Club, the New Boston Riding Club, Society of the Army of the Potomac and other organizations, in all of which he has kept up a lively interest. In 1911, his legal residence was in Boston, and he also had a summer home in Beverly.

On December 12, 1882, Mr. Wallace married Eunice, daughter of Jesse and Nancy Bates Sprague.

WILLIAM HENRY WELLINGTON.

William Henry Wellington was born in Cambridge, Middlesex County, Mass., Dec. 19, 1849; son of Willlam W. (a physician) and Martha B. (Carter) Wellington. He attended the public schools in Cambridge until eighteen years of age, and in November, 1867, entered the employ of N. Boynton & Company, cotton duck merchants and manufacturers, located at 87 Commercial Street, Boston, with which house, in various positions, he remained during his entire business career.

In 1880 Mr. Wellington was admitted to the firm, and in 1901, when the name was changed to Wellington, Sears & Co., he became senior member. (See sketch of Wellington, Sears, & Co., *Ibid.*) This commission house serves as distributors for some seventeen mills located in the north and south, and in many of these companies Mr. Wellington has become financially interested. He is the president of the Lanett Cotton Mills and the Lanett Bleachery & Dye Works, and a director of the West Point Manufacturing Company, Lanett Cotton Mills, Riverdale Cotton Mills, Brookside Mills, Boott Mills, Suncook Mills, Gluck Mills, Warwick Mills, Lanett Bleachery & Dye Works, Sherman Mfg. Co., Dixie Cotton Mills and the Columbus Mfg. Co.

Mr. Wellington is connected with several financial institutions, being a director of the National Shawmut Bank, the Boston Safe Deposit & Trust Company, the John Hancock Mutual Life Insurance Company, all of Boston, and also served on the Suffolk County Court House Commission. He is a member of the Algonquin, Exchange and Athletic Clubs.

Mr. Wellington married, Oct. 20, 1875, Florena, daughter of John G. Gray and Jane A. (Living) Gray, of Roxbury, and had three children: Stanwood G., who, in 1908, joined his father in the firm of Wellington, Sears & Co., Raynor G. and Anna F.

ELEAZAR BOYNTON.

Eleazar Boynton was born in Rockport, Essex County, Mass., Sept. 29, 1824. He was a son of Eleazar and Sally (Blatchford) Boynton. He was educated at public and private schools in his native village and at Phillips Academy, Andover. In 1845, being then just of age, he removed to Boston and entered the business house of Boynton & Miller, wholesale grocers and ships chandlers, of which Nehemiah Boynton was the senior partner, and in 1849 was made a member of the firm. Later, he entered into partnership with A. F. Hervey, and the firm became Boynton & Hervey; in 1855, the two firms consolidated under the name of N. Boynton & Co. In 1868, on the death of the Hon. Nehemiah Boynton, Eleazar Boynton became the senior member of the firm, the name remaining as of old, N. Boynton & Co., until 1901, when it was changed to Wellington, Sears & Co.

Mr. Boynton removed to the historic town of Medford, in 1856, and resided there up to the time of his death. He was vice-president and trustee of the Medford Savings Bank, a director of the Blackstone National Bank of Boston, president of the United States Cotton Duck Dealers' Association, and president of the Russell Mills of Plymouth, Mass.

Mr. Boynton took a leading part in public affairs, and was active in benevolent and religious circles. He was a member of the Boston School Committee when he lived in that city, and an active member of the same committee in Medford when he resided there. He was a member of the board of selectmen in 1861, when the War of the Rebellion commenced, and chairman of the board in 1862. To him is largely due the credit Medford has enjoyed as one of the most loyal communities in that most critical time in the nation's history. He represented the town in the House of Representatives, in 1865, and the First Middlesex District in the Senate, in 1885-86. His sympathies were with the Congregational Church, which for generations had been the church of his family, and for more than forty years he was a member of the Mystic Congregational Church, in Medford.

Mr. Boynton married, October 9, 1852, Mary, daughter of Simeon and Sally (Plummer) Chadburne. He had four children: Mary Dodge; Edward P., who followed his father as a member of the firm of Wellington, Sears & Co.; Nehemiah, who is now minister of the Congregational Church, Brooklyn, N. Y., and Elizabeth L. Boynton.

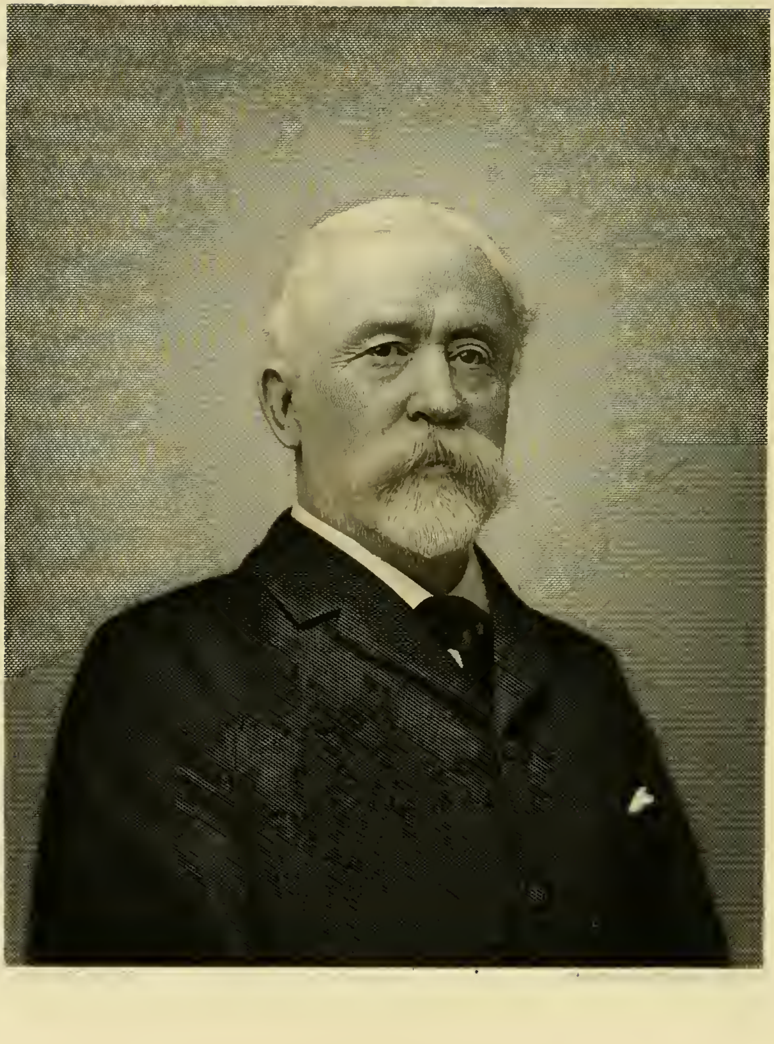
The subject of this sketch died at Medford, Mass., June 6, 1901.

THEODORE WILBUR BENNETT.

Theodore Wilbur Bennett was born in Charlestown, Mass., Sept. 9, 1844; son of Jonas and Celinea Gardner (Grover) Bennett; grandson of Stephen and Lucy (Winn) Bennett and of Simeon and Celinea (Gardner) Grover, and a descendant of Thomas Grover, who came from England to Charlestown, Massachusetts Bay Colony, in 1642; through Thomas and Sarah (Chadwick) Grover; Andrew and Mary Grover, and James and Sarah (Austin) Grover. Jonas Bennett was a banker, and Theodore W. Bennett was educated at Nathaniel Allen's school in West Newton and at the Boston Latin School. He left the Latin School before completing the Boston Latin School. He left the Latin School before completing the course, in order to accept a position with the house of N. Boynton & Co., commission merchants, who made a specialty of representing mills that produced cotton duck. He remained with the firm up to 1868, when he resigned, to engage in business on his own account as agent for several New England and Baltimore cotton mills in London, England, where he remained up to 1869, when he returned to Boston to accept a partnership in the firm of N. Boynton & Co., the vacancy being caused by the death of the senior member of that firm, and this business relation was maintained until his death, except during an interval of three years, 1889-91, when he was a partner in the firm of John L. Bremer & Co. He was an early advocate of the manufacture of cotton fabrics in the cotton States, building the mills near the cotton fields and opening a new industry in that section. As early as 1887 this desired experiment was tried by the firm of N. Boynton & Co., who were instrumental in the erection of a cotton mill at Langdale, Ala., near West Point, Ga., which was incorporated 1887 as the West Point Manufacturing Company, expressly for producing cotton ducks in various widths and weights, and this mill grew to 25,000 spindles and 500 looms. In 1894 the firm, largely through Mr. Bennett's influence, established at Lanett, Ala., near West Point, the Lanett Cotton Mills, incorporated in 1893 with a capital of $1,000,000. The "Lanett" was made up from the first syllable of the name of the president of the mill, L. Lanier, and the last syllable of the name of Bennett. The firm of N. Boynton & Co. became Wellington, Sears & Co., with offices both in Boston and New York.

Mr. Bennett was a foremost factor in promoting the cotton industry in the South, and it has been well said of him that "his friends were numberless and his enemies none."

In September, 1869, Mr. Bennett married Anna Brown, daughter of Edward and Sophia (Whitney) Mellen, of Wayland, Mass., and they had eight children. Mr. Bennett died at his home in Wayland, Mass., June 29, 1899.



Geo F Fabyan

GEORGE F. FABYAN.

George F. Fabyan was born in Somersworth, N. H., June 26, 1837. He was the only son of Dr. George and Abigail (Cutts) Fabyan, the latter coming from York, Me.

About a year after the birth of his son, Dr. Fabyan's health began to fail, and on this account the family, in 1838, removed to Gorham, Me., where the early life of the subject of this sketch was spent. Completing the educational course afforded by Gorham Academy, he entered Phillips Academy, at Andover, where he studied for three years. On leaving this latter school, it was a keen disappointment to Dr. Fabyan that, owing to lack of resources on account of his own ill health, his son could not enter college and follow him in the medical profession. Consequently, when but a boy of seventeen years, George F. Fabyan left home and came direct to Boston, where, after a long search for employment, he entered, as errand boy, the services of George W. Chipman (later Deacon Chipman, of Tremont Temple) who at that time was conducting a dry goods establishment at the corner of Hanover and Blackstone Streets. Being bright and quick to perceive, young Fabyan soon noticed that the business of Boston centred in what is now the downtown district, and, watching his opportunity, at the end of a year's time he left the employ of Mr. Chipman and obtained employment with James M. Beebe & Co., a wholesale dry goods house on Kilby Street, with which concern he remained for twelve years. During this latter period, Mr. Fabyan had become so proficient in and acquired such a knowledge of the ramifications of the business that when, after the war, James M. Beebe & Co. discontinued, he was able to form a connection as buyer of New England cottons with A. T. Stewart & Co., New York merchants, and immediately opened an office at 140 Devonshire Street, Boston. While working for the interest of this concern he endeavored also to further his own by increasing his acquaintance with the textile trade. The firm of J. S. & E. Wright, cotton commission merchants, occupied offices in the same building, and they were much interested and held Mr. Fabyan in highest favor. On resigning from the position of buyer for the firm of A. T. Stewart & Co., therefore, Mr. Fabyan, at the earnest solicitation of the Wrights (who were elderly gentlemen and about to retire from business) entered their employ with the prospect of becoming a member of the firm. In the early seventies the style of Wright, Bliss & Fabyan was formed, and a little later the Wrights died, after which the firm name was changed to Bliss, Fabyan & Co.

Under the new management, the concern made an enormous and steady increase, until, in 1911, it was the largest of its kind in the country, having branch offices in Boston, New York, Philadelphia and Chicago, the volume of its business per annum being ten times greater than that of

the original house, and handling the output of the great mills of Lewiston, Biddeford and Fall River, in addition to that of many smaller plants.

When the great firm of F. Skinner & Co. failed, Bliss, Fabyan & Co. removed to their stand at the corner of Devonshire and Franklin Streets, succeeding to a large part of the business. At this location they remained until 1872, when, in the great Boston fire, they were burned out. After a lapse of about a year (during which time the firm was located in a small annex attached to Music Hall) Bliss, Fabyan & Co., on the completion of the building at the corner of Summer and Devonshire Streets, which was built expressly for them, removed to the same, the firm remaining an old-fashioned partnership.

In addition to its regular business, that of the distribution of cotton, the company had very large investments in mill properties, Mr. Fabyan being treasurer of the Androscoggin Mills, of Lewiston, Me., and several other corporations. Mr. Fabyan was also treasurer and a director of the Otis Company, the Boston Duck Company and the Columbian Manufacturing Company, and was at one time a director of the Lewiston Bleachery, Thorndike Company, Cordis Mills, Pepperell Manufacturing Company, Old Colony Trust Company and the Metropolitan Warehouse Company.

Mr. Fabyan was one of the two Massachusetts members of the Jekyl Island Club, that exclusive coterie which forms a colony of its own on an island off the coast of Georgia; he was a member of the Metropolitan Club, of New York; an officer at one time of the Eastern Yacht Club, and a member of the Art, Union and Country Clubs of Boston.

In 1864 Mr. Fabyan married Isabella Littlefield, of Roxbury, Mass., five children being born to them, three sons and two daughters: George, who is at the head of the Chicago office of the house; Francis W., a member of the firm attached to the Boston headquarters; Marshall, who followed the profession of his grandfather (the grandfather later in life regained his health and followed his son to Boston, where he became a prominent practitioner with offices on Bowdoin Street), and, being a graduate of the Harvard Medical School, served at the Massachusetts General Hospital and as professor at Johns Hopkins Hospital, Baltimore, Md.; Gertrude, now Mrs. Isaac R. Thomas, and Isabella, at home with her mother.

Mr. Fabyan, after an illness of several months, died at his home in Brookline, Jan. 18, 1907.

ORLANDO H. ALFORD.

Orlando Hiram Alford, son of Samuel and Mary (Slayton) Alford, was born in Perkinsville, Vermont, Sept. 18, 1840. He was educated in the Springfield and Woodstock Seminaries, Vermont, and in 1856 came to Boston and associated himself with the firm of Edwards, Nichols & Richards, in the dry goods business. This partnership later dissolved and was succeeded by Morse, Shepard & Co., in which concern Mr. Alford became a partner. In 1877 he engaged in the commission business, being employed by Wright, Bliss & Fabyan, of Boston. Within two years he was admitted to this partnership, the style of which, in 1881, was changed to Bliss, Fabyan & Co.

Mr. Alford also served the Bates Manufacturing Company as president and director; the Androscoggin Mills, the Boston Duck Company and the Otis Company as treasurer and director; the Columbian Manufacturing Company, Cordis Mills, Thorndike Company, Lewiston Bleachery, First National Bank and City Trust Company as director; the Franklin Savings Bank as trustee; the Merrimac River Towing Company as president, and the Union Water Company as president, treasurer and director.

On Jan. 24, 1865, Mr. Alford married Ellen J., daughter of James P. and Lucinda (Boynton) Balch, of Weathersfield, Vt., and had two children, Martha A. and Edward B. Mr. Alford died June 12, 1908.

JOHN D. W. JOY.

John Dolbeare Waters Joy was born in Boston, Mass., April 6, 1828. He was the son of John Randall and Nancy (Dolbeare) Joy, grandson of Thomas and Polly (Day) Joy and a direct descendant of Thomas and Joan (Gallop) Joy, who came from England to Boston about 1635. Thomas Joy was a builder, house carpenter and millwright, and built the first town house in Boston, which was completed in the year 1658 on the site now occupied by the old State House. The father of John D. W. Joy was a calico printer. The subject of this sketch attended the Eliot School, in North Bennett Street, Boston, and at an early age left to enter business. He soon found employment with Mason, Lawrence & Co., dry goods commission merchants, where his character and ability gained him admission as a partner, the firm being then known as Lawrence & Co. In 1866 he left this house to become an active member of the firm of Frothingham & Co., and on January 1, 1873, shortly after the death of Mr. Frothingham, he established the firm of Joy, Langdon & Co., having offices in Boston and New York, of which he continued

to be an active member up to the time of his death. For nearly fifty years he held a prominent place in the dry goods commission business, and had the closest connection, as selling agent, stockholder, director and president, with many of the largest mills in New England.

During the latter part of his business career he was very closely identified with the Hamilton Manufacturing Company, of Lowell, Mass.; the Newmarket Manufacturing Company, of Newmarket, N. H., and the Hamilton Woolen Company, of Southbridge and Amesbury, Mass., and was for a number of years one of the directors of the two latter companies. He was a director of the New England National Bank, and one of the Board of Managers of the Suffolk Savings Bank for nearly forty years. Although he was eminently a business man and always gave his business his active and close attention, even up to a few hours of his death, yet he was a man of broad views, and his fine physique enabled him to do a large work in many other fields. When quite a young man, he belonged to the Howard Benevolent Society, and was assigned to the personal charge of the "North End" district. It was in this society that he organized a relief for the needy, upon substantially the present plans of the Associated Charities of the present day. He was one of the first and most active trustees of the Home for Aged Men in Boston, of which he was for many years vice-president.

Mr. Joy was deeply interested in and served on the committee which raised funds for the equestrian statue of Washington in the Public Garden. He never entered into active political life, although he was a lifelong Republican, and served, by request, as a member of the Finance Commission appointed by ex-Mayor Curtis, in 1896. He was president of the Bethany Home for Young Women at the time of his death, and was one of the prime movers in establishing this home. He realized, to the fullest extent, the value of the highest education, and gave unstintingly of his time and means to Dean Academy and Tufts College. He was treasurer of the former for many years, and it was mainly through his efforts that the academy was rebuilt promptly after a disastrous fire. In 1880 he was elected one of the Board of Trustees of Tufts College, and served as a member of the Executive Board and as chairman of the Finance Committee. He held the office of president of the Board of Trustees for over ten years. He was brought up in the Universalist Church, and the Universalist Sabbath School Union was presided over by him for many years. The Massachusetts General Convention of that body owes much of its present financial condition to his thirty-five years as president. The Universalist General Convention (the national organization) elected him its president for many successive years, and he afterward served as chairman of its Board of Trustees. As treasurer of the Universalist Publishing House for thirty years, he had the satisfaction of seeing that institution firmly established. He was "father of the Universalist Club,"

R. M. CHANDLER PINX

ENG BY E. G. WILLIAMS & BRO. NY

Edgar Harding.

rarely missing one of its meetings. He always lived in Boston, and during the last twenty-six years of his life he resided at No. 364 Boylston Street.

His widow, a son, Franklin Lawrence, and a daughter, Mrs. Arthur E. Mason, survived him. Mr. Joy died in Boston, Oct. 4, 1898.

EDGAR HARDING.

Edgar Harding was born in Millville, Massachusetts, Dec. 5, 1844, son of Charles Lewis and Julia Ann (Bowen) Harding, and a descendant of the first settler of the name, Abraham Harding, a leather dresser and glover by trade, who was born in England about 1615 and came to Massachusetts Bay Colony, the first record of his name appearing on the register of the town of Dedham, Massachusetts Bay Colony in 1638. Early in 1639 he married Elizabeth Harding, who came from England to Boston in 1635, being then thirteen years of age.

In 1642 Abraham Harding removed to Braintree. There he united with the church, took the freeman's oath, and by purchase became possessed of a town-right, house, barn and fifty-three acres. In 1650, when Medfield as well as Medway was granted to "Dedham Men," he became one of the grantees, doubtless because of his early proprietorship in Dedham, and he immediately removed to Medfield, where he built what was a costly house for that period. He died suddenly, March 22, 1655, leaving his widow with four children. This Elizabeth Harding appears to have been a "superior and devoted" woman, and to have left a lasting influence upon her descendants. In 1656 she married John Frary and had two daughters. Mr. Frary died April, 1670, and, in 1673, she married Captain Thomas Dyer, a wealthy cloth worker of Weymouth. His son Abraham was a man of character and consideration, and was chosen a member of the town committee Nov. 23, 1713, when Medfield held its first town meeting; selectman in 1715-16; moderator in 1617, and was appointed to lay out land for the first minister. His son Samuel married Mary Cutler and his son Elisha was highly considered and was chosen by his townsmen of Franklin, Mass., one of a committee to protest against the acts of the United States Government in the War of 1812. According to tradition, his wife, Ruth Hewins, was a very superior woman. His son, Hon. Lewis, was chosen to many important town offices, and acted as town clerk from 1815 to 1823. In 1824 he bought a farm at Stony Brook North Wrentham and lived there until 1855. In 1848 he represented Norfolk County in the Massachusetts Senate. He married Irene, daughter of Fisher H. Hartshorne, of Walpole, and (second), Polly Merrifield, who survived him.

His son, Charles Lewis, was the treasurer of the Lowell Carpet Company, and married Julia A., daughter of Comon and Elizabeth (Aldrich) Bowen, of Scituate, R. I.

The subject of this sketch spent his early life in Burlington, Vt., and Cambridge, Mass., and received his education at Worcester Academy and Chauncey Hall School, Boston. He entered his father's dry goods commission house, and Jan. 1, 1875, became a partner, the style then being Harding, Colby & Co., and so continued when the firm became Harding, Whitman & Co., December, 1887, and was senior member of the concern after the death of his father in 1891. He was treasurer for many years of the Merchants' Woolen Mills, at Dedham, Mass.; president and director of the Whitman Mills in New Bedford. He also succeeded his father as director of the North National Bank, was a director of the Rutland R. R., and selling agent during the copartnership of Harding, Colby & Co., of the Merchants' Woolen Co., Scofield Manufactory, Thorn Dolan & Co., Philadelphia; Washington Mills, Lawrence; Sprague Print Works, and of the Salisbury Mills. Under the copartnership of Harding, Whitman & Co., he was agent of the Arlington Mills, Whitman Mills, Manomet Mills, Eddystone Print Works, and of the Southern Cotton Yarn Mills.

Mr. Harding was a Republican in politics. He belonged to the Algonquin, Union and other social clubs. He was an enthusiastic yachtsman and a member of the Eastern, Beverly and other yacht clubs. He maintained a summer residence at Woods' Hole and a home in Beacon Street, Boston. He married, Nov. 8, 1871, Sara Marston, daughter of Josiah and Mary Ann (Dyer) Robinson, of Boston, and their children were: Ruth, Charles L., Josiah Robinson, Edgar, Jr., Priscilla, and Marston Harding.

Mr. Harding died in Boston, Oct. 28, 1905.

ISAAC PARKER.

Isaac Parker was born at Jaffrey, Cheshire County, N. H., April 14, 1788, the son of Abel and Edith (Jewett) Parker. Mrs. Parker was the daughter of Jedediah Jewett, of Pepperill, Mass., and Isaac's father was a descendant of Abraham Parker, one of the original settlers of Chelmsford, Mass. The only school attended by the subject of this sketch was the district school of his native town, but his learning extended far beyond this limit, for he inherited a natural taste for reading, and was not slow to take advantage of his father's library, composed of a collection of books of unusual variety in that region. But neither was his education one of books alone, for labor filled the intervals of school terms, the duties

of the farm in the milder seasons and the household manufactures in the winter months commanding large portions of his time. Instead of going, as did his brothers, to college, Isaac very early determined on a mercantile career, and January 31, 1803, or while still in his fifteenth year, he entered the employ of David Page and Luke Wheelock, merchants, who had established a good miscellaneous business in Jaffrey and later engaged in the manufacture of potash at Jaffrey, flour at Otter Creek, and some textile fabrics at Middlebury, Vermont, their establishment at the latter place having been the first cotton factory in the State. On the 29th of August, 1806, Mr. Parker removed to Middlebury, Vermont, which place was subsequently made the headquarters of the concern, and affairs were conducted under his supervision. Reaching his majority in 1809, however, Mr. Parker decided to seek his fortune "in the western wilds," which was probably no farther west than Buffalo, N. Y., but just at that time Samuel Smith, of Peterborough, N. H., offered to establish the young man in a business which he was about to open up at Keene, N. H., and Mr. Parker, accepted the offer and later became a partner. In 1811, the style was changed to Parker & Hough, Dr. Hough, of Keene, becoming Mr. Parker's active associate. The firm occupied a three-story building, the lower story being used for the usual purposes of a country store when much of the business was done by barter, and the upper portion of the building was conducted as a factory for the manufacture of satinets.

During the War of 1812, Mr. Parker participated in the defence of his country; accordingly we find him connected with the Keene Light Infantry—an independent company of which he was commissioned captain, June 7, 1813. At the close of hostilities he went to Boston, Mass., and became a partner of Silas Bullard under the style of Bullard & Parker, at 31 Central street, but he soon withdrew and in 1820 established with Jonas M. Melville the firm of Isaac Parker & Co. for the sale of American manufactured goods, this being the nucleus of the well-known commission house of Parker, Wilder & Co., Mr. Parker being connected with the business until his death.

Mr. Parker was also publicly identified in politics. He was a member of the Common Council of Boston, in 1824-25-26-32-38-39-40, serving on the standing committee of finance and for two years as chairman of his branch of the joint committee on the introduction of water. He likewise served for three years as a representative from Boston in the House of Representatives of 1830-31, 1831-32, and 1842. He was a director in a large number of business corporations, one of the original trustees of the Mount Auburn Cemetery, a trustee under the mortgage of the Sullivan R. R. in New Hampshire, and for sixteen years president of the Traders' Bank of Boston. He was also a resident member of the New England Historic Genealogical Society.

November 17, 1812, Mr. Parker married Sarah, daughter of Rev.

Laban and Mary (Minot) Ainsworth, and had issue, four sons and four daughters.

An accident, by which he was thrown from his carriage, resulted in Mr. Parker's death, at Boston, May 27, 1858.

MARSHALL PINCKNEY WILDER.

Marshall Pinckney Wilder was born at Rindge, N. H., September 22, 1798. He was the son of Samuel Locke and Anna (Sherwin) Wilder, and descended through Ephraim and Lucretia (Locke) Wilder; Ephraim and Anna Wilder; Ephraim and Elizabeth Stevens Wilder; Nathaniel and Mary (Sawyer) Wilder; from Thomas and Anna Wilder. This Thomas, the first settler, came from Berks County in England to Charlestown, Mass., with his mother, Martha Wilder, a widow, and settled in Charlestown, Mass., in 1640, where he married during the same year. His father was the nephew of Samuel Locke, D. D., president of Harvard, and was himself a representative in the Legislature of New Hampshire for thirteen years and held many important public offices in the town of Rindge. His mother was the daughter of Jonathan Sherwin, of Rindge, N. H. His grandfather, Captain Ephraim Wilder, was a representative of the town of Sterling, and in this capacity, in 1788, voted for the adoption of the Constitution of the United States; his great-grandfather, Ephraim, and his great-great-grandfather, Nathaniel, rendered meritorious service in the Indian wars, Nathaniel being killed by the Indians at Lancaster, July, 1704.

The subject of this sketch entered the common school of his native place at the age of four, and at twelve began his course at the new Ipswich Academy. At the age of sixteen he determined to follow the occupation of farming and began to work upon his father's lands; but the increase of his father's business took him into the latter's store, and at the age of twenty-one he was taken into partnership. At the same time he was appointed postmaster of the town. But the country town did not suffice his energies, and in 1825 he removed to Boston and became a member of the firm of Wilder & Payson, West India Traders, in Union street; later the firm became Wilder & Smith, doing business in North Market Street, and still later he followed the same business under his own name at No. 3 Central Wharf.

In 1837, with Isaac Parker and Abraham W. Blanchard, he established the firm of Parker, Blanchard & Wilder, for the sale of domestic goods on commission. A few years later William A. Parker succeeded Mr. Blanchard, and the firm became Parker, Wilder & Parker; other members

of the firm later on were Ezra Farnsworth, Francis J. Parker, Samuel B. Rindge, John Byers, William H. Wilder, Benjamin Phipps, William H. Sherman, James Street and Marshall Shepard, and the firm style became Parker, Wilder & Co., which was first located in Water street, then in Pearl street, then Winthrop Square, where its offices were destroyed in the Boston fire of 1872. Mr. Wilder was a member of this firm almost up to the time of his death. He was also a director in many commercial and financial companies and institutions, and yet found time to take an active part in public and political life. He was a member of the State Legislature in 1839; a member of the Governor's Council in 1849; president of the State Senate in 1850 and one of the founders of the Constitutional Union party in 1860. Throughout the war he was a firm adherent of the United States Government.

Soon after his arrival in Boston, Mr. Wilder purchased Governor Increase Sumner's house and grounds in Dorchester, and there made his home, devoting all his leisure time to horticulture, agriculture and pomology, for which he had the taste from boyhood.

He was one of the instigators and promoters of the Massachusetts Horticultural Society, and in 1840 was chosen its president, holding that office until 1848, when he resigned.

He instigated in 1848 the organization of the American Pomological Society, and was elected its president, an office which he filled for many years. He assisted in the organization of the Norfolk Agricultural Society in 1849, and was its president for twenty years. To his efforts were largely due, also, the inception and growth of the following institutions: The Massachusetts Central Board of Agriculture, of which he was president until the Board of Agriculture became a department of the State Government; the Massachusetts School of Agriculture in 1858, of which he was elected president; Massachusetts Agricultural College in 1863, of which he was first trustee; United States Agricultural Society in 1852, of which he was president for six years. He was a member of many horticultural and agricultural societies both at home and abroad, notably the Royal Horticultural Society of London; Royal Horticultural Society of Paris; Horticultural Society of Frankfort-on-the-Main and the Société Van Noons, of Belgium, of which he was commissioner for America. He was an honorary member of the Massachusetts Society for the Promotion of Agriculture.

He was one of the United States Commissioners to the Universal Exposition, at Paris, where he was appointed chairman of the Committee on Horticulture and the Cultivation and Products of the Vine. Horticultural Hall is adorned with an admirable marble bust of Mr. Wilder, presented to the Society in 1863 by Charles O. Whitmore, Esq.

In 1859 Mr. Wilder presided at the first public meeting held in Boston in relation to the collocation of certain institutions on the Back

Bay lands where the handsome building of the Boston Society of Natural History and of the Massachusetts Institute of Technology now stand. Of the latter institution he was vice-president and later chairman of its Society of Arts. In 1860 he was one of the special committee appointed to receive the Prince of Wales at the banquet given in his honor.

This singularly versatile man added to his other tastes military proclivities. He was enrolled in the New Hampshire militia at sixteen and was commissioned as an adjutant at twenty-one. He organized and equipped the Rindge Light Infantry and was chosen its captain. At twenty-five he was elected lieutenant-colonel, and at twenty-six was commissioned as colonel of the 12th regiment. Soon after his removal to Boston he joined the Ancient and Honorable Artillery Company, and in 1857 became its commander. He was a Freemason and received all of the degrees, including the thirty-third, and was Deputy Grand Master of the Boston Grand Lodge of Massachusetts, and a delegate from that body to the World's Convention of Masons in Paris, A. D., 1867.

In January, 1868, Mr. Wilder became president of the New England Historic-Genealogical Society, an office which he filled until 1886, and to his efforts were mainly due the building of its handsome edifice on Somerset Street.

He was an able and eloquent speaker and a prolific writer upon the subjects in which he was mainly interested. The list of his writings is too long to be here inserted entire, as they would have made many volumes had they been collated.

Among his published addresses were: On Laying the Corner Stone of the First Massachusetts Horticultural Hall, Boston (1844); on the 225th Anniversary of the Settlement of Dorchester (1855); annual addresses before the Historic Genealogical Society (1868-73); Lectures on California (1871); and "The Hybridization of Plants" (1872); "On the Progress and Influence of Rural Art" (1872); addresses before the American Pomological Society (1848-73); and the United States Agricultural Society (1852-6); Dartmouth conferred upon him the degree of Ph. D. in 1877, and Roanoke that of LL. D. in 1884.

Mr. Wilder married, in 1820, Tryphosa, daughter of Dr. Stephen Jewett, of Rindge, who died in 1831, leaving four children. He married (second) August 29, 1833, Abigail, daughter of Captain David Baker, of Franklin, Mass., who died in 1854, leaving five children; and married (third) September 8, 1855, Julia Baker, sister of his second wife, by whom he had two sons, Edward Baker and Marshall Pinckney Wilder.

He died Dec. 16, 1886, at his residence in Dorchester, aged eighty-eight years.

EZRA FARNSWORTH.

Ezra Farnsworth was born January 5, 1813, at Groton, Mass. He was the second son of Abel and Polly (Goodell) Farnsworth; grandson of Ezra, Jr., and Betsey (Sheple) Farnsworth; great-grandson of Ezra and Abigail (Pierce); great-great-grandson of Benjamin and Mary (Prescott) Farnsworth, and so a direct descendant in the sixth generation from Matthias Farnsworth, or Farnworth, as the name was first written, who first appears at Lynn, Mass., where he was a resident in 1657; later he moved to Groton, where he is first mentioned in the records, November 27, 1664; he married Mary Farr, the daughter of George Farr, of Lynn, a shipwright who was sent to Salem in 1629 by the Company in London.

Ezra Farnsworth, the subject of this sketch, was educated at the common schools in Groton and in the Groton Academy. At the age of fifteen he became a clerk in a store in Groton, and two years later wended his way to Boston, where he obtained a similar situation with the firm of Gordon & Stoddard, a dry goods importing house; he evinced his capacity for business in a marked manner, and in 1835, being then twenty-two years of age, he was despatched to Europe in the capacity of purchasing agent for the firm, remaining for two years in that employment, and during the two years subsequent to his return to the United States was with the same house. He then entered into partnership under the firm name of Farnsworth & Shaw, dealers in dry goods, and continued the business up to 1850, when he entered the commission house of Parker, Wilder & Co., in which he became the senior partner and was connected with the firm up to the time of his death. He was associated with the Boston Board of Trade from its inception in 1854, and became its vice-president in 1873. He was a director of the Boston National Bank from 1856, and was a member of the municipal government in the same year. From 1865-72 he was a trustee of the Massachusetts General Hospital.

He was affiliated with the Congregational Church under the pastorate of Rev. Lyman Beecher, and later was a member of the Park Street Church, of which he was a deacon from 1853-4 up to his death. He was associated for many years with the Board of City Missions and served as its president from 1848 to 1850. In 1868 he was chosen a member of the Prudential Committee of the American Board of Foreign Missions, and also chairman of its Finance Committee. He was chairman of the building committee for the Congregational House in Beacon Street. He was interested in Bradford Academy and gave liberally to that and other institutions of learning. In 1840 he married Sarah Melville, daughter of Isaac Parker, senior partner of Parker, Wilder & Co., and had eight children: Mary Rice, married John Lewis Bremer; Ezra; Alice; Isaac Parker, died in 1864; Sarah, married James Frothingham Hunnewell; James E., died in 1854; William, who was a member of Farnsworth, Thayer & Co., in 1910, graduated from

Harvard in 1877 and married Lucy Holman Burgess; Helen, married James Means.

Mr. Ezra Farnsworth died at his residence, 23 Commonwealth Avenue, Boston, Mass., July 4, 1890, aged seventy-seven years.

JOHN HOPEWELL.

John Hopewell was born in Greenfield, Franklin County, Mass., February 2, 1845. His father, also John Hopewell, was a native of London, England, and came to the United States when he was but fourteen years of age. He decided to learn the cutler's trade, and after serving as apprentice for the full term of seven years, he became a manufacturer of cutlery. In 1843 he married Catharine Mahoney, of Greenfield, Mass., and had six sons, of whom the subject of this sketch was the eldest. John, Jr., after his twelfth year, worked in the cutlery shop six months of the year and attended school the other six months. At the age of fourteen, he left school entirely and devoted his whole time to work. For three years, he was employed by Lamson & Goodnow, table cutlery manufacturers in Shelbourne Falls, Mass., and then went to Springfield, Mass., in 1861 where he secured a position in the machine shops of the United States Arsenal.

It was while he was in Shelbourne Falls that Mr. Hopewell, then a lad of fifteen, chanced to read the "Life of Gen. Nathaniel P. Banks," who was governor and representative from Massachusetts in the United States Congress and Speaker of the House. The success of the "Bobbin Boy" achieved under circumstances similar to his, and with no greater advantages than those which he enjoyed, presented to young Hopewell's mind the idea of an honored and respected citizen, and convinced him there were other and higher objects in life than a man's daily wage. Determining to fit himself for a greater career, he devoted himself assiduously to the reading of books upon history, travel, political economy and especially the biographies of great men.

When he went to Springfield, he continued to make good use of his leisure hours. He attended night school, and being a ready speaker, a trait which he had inherited from both parents, he joined a debating society. By the time he was twenty-two years of age, he became convinced that he could find something to do which would be more in accord with his tastes than working at the bench. He announced his decision to his parents, and one day walked out of the shops at noon and went forth like Abraham of old, not knowing whither he was going. He spent a portion of the following year at a business college in Springfield, where he came in contact with a different class of men, all intent upon a business career.

John Hopewell

From the business college he went to Albany, where he obtained a position as selling agent for a publishing house. Misfortune, however, overwhelmed his employers, and he in consequence returned to Springfield, and secured a position with Josiah Cummings, a manufacturer of saddlery and a jobber of blankets and robes manufactured by L. C. Chase & Co., of Boston, with which firm, three years later, Mr. Hopewell associated himself as salesman. The business grew rapidly, and in a few years he was admitted to the partnership of L. C. Chase & Co. and became the head of the house in 1887. January 31, 1885, he became treasurer of the Sanford Mills, a large manufacturing enterprise resulting from the business alliance of L. C. Chase & Co. and Thomas Goodall, of Sanford, Maine, manufacturers of mohair plush robes and blankets, and he continued to hold that office until Aug. 22, 1896, when he was succeeded by his brother, Frank.

Mr. Hopewell was a man of multifarious interests and held many positions of responsibility and trust, being president of the Reading Rubber Mfg. Co., of Reading, Mass., president of the Electric Goods Mfg. Co., a large electrical manufacturing corporation of Boston and Canton, Mass., director of the National Bank of Redemption and First National Bank, and served as director and officer of many other industrial corporations. He was always interested in political questions, especially on subjects pertaining to the manufacturing interests of New England. He was one of the organizers of the Home Market Club of Boston, and was a member of the Executive Committee or a director ever since its organization, and was a director of the Boston Merchants' Association. He represented his district in the General Court of Massachusetts in 1892; declined to be a candidate for the Republican nomination as Representative to the 53d Congress, was a delegate to the Republican National Convention, which met in St. Louis in 1896, which nominated McKinley. Mr. Hopewell travelled extensively in this country and in Europe. He was a member of the Home Market Club, the Cambridge Club and the Cambridge Republican Club, of both of which he was president, the Algonquin Club of Boston, the Boston Art Club, the Boston Athletic Association and the Colonial Club. He was also president of the Cambridge Citizens' Trade Association. He was a Universalist.

In October, 1870, Mr. Hopewell married Sarah, daughter of Charles and (Blake) Blake, and had five children, Charles F., Frank B., Mabel G., Nulla H. and Henry Chase. The life of Mr. Hopewell is typical of that of thousands of young men, who, without influence or friends to push them forward, have made a place for themselves and won recognition in the business world; not through any special talent or genius, but by painstaking, persistent, hard work, never counting the hours, whether working for themselves or their employers.

WILLIAM WHITMAN.

William Whitman was born at Round Hill, Annapolis County, Nova Scotia, May 9, 1842. His father, John Whitman, was the great-grandson of John Whitman, who was born in Massachusetts; the great-grandson of John Whitman, who came from England prior to 1638 and settled in Weymouth, Massachusetts Bay Colony. John Whitman, great-great-grandfather to William Whitman, left Massachusetts with the large body of Loyalists who were distributed by the action of the Revolutionists and took possession of the fruitful fields of Acadia. He settled on a farm near Annapolis known as Round Hill, and the estate is still in possession of the Whitman family. John Whitman (father of the subject of this sketch) married Rebecca Cutler, a direct descendant of Ebenezer Cutler, a conspicuous Loyalist when attachment to the cause of the King of England made him a refugee in the stormy times of the American Revolution, and he settled in Halifax, Nova Scotia, in 1778. William Whitman was a child of this marriage, and spent his early years at his home in Halifax, and in the neighboring town of Annapolis, where he attended a small country school and the Annapolis Academy. His school days were ended when he was eleven years old, circumstances compelling him to make his further way in the world unassisted by parents or friends. In his case the absence of wealth and the deprivation of careful home shielding was no bar to success, and coming as he did into the active period of life with an inheritance of physical strength derived from families conspicuous for longevity and good health, he was well equipped for the battle before him. He had acquired a good, legible handwriting which he found always a good recommendation to business men, and as he had derived from his early training and from his honest-dealing, God-fearing ancestors, principles of business righteousness, he had indispensable requisites for starting out in a safe road to success. He left his home May 13, 1854, to take a situation in the office of a wholesale dry goods store in St. John's, New Brunswick, but the limited opportunities of that city became manifest before the end of two years' service, and he determined to seek his fortune in Boston. There, without the aid of friends or influence, he presented himself as an applicant for the position of entry clerk to the proprietors of the house of James M. Beebe, Richardson & Co., successors to James M. Beebe, Morgan & Co., well known by the business men of Annapolis, and whose names were familiar to the boy of fourteen. He attracted the merchants by his many and positive assertions of capability, and he remained with the house for eleven years, being successively promoted through the various grades of clerkship, not leaving until the firm was dissolved in 1867. He then was sought out as treasurer by the Arlington Woolen Mills, for which the firm of R. M. Bailey & Co. were the selling agents, and of which Mr. Bailey was president. He held the position for two years, when

ENG BY E G WILLIAMS & BRO NY

Wm Whitman

JAMES H LAMB CO

he resigned, owing to his dissatisfaction with the management, and purchased an interest in a woolen mill in Ashland, N. H., where he began the manufacture of woolen goods on his own account. He had been in Ashland only six months when the Arlington Mills were reorganized, and the new management urged him to return as treasurer, which he did. His connection with the Arlington Woolen Mills as treasurer extended from 1867 to 1902, a period of thirty-five years, with the exception of the six months at Ashland, N. H. In 1902 he was elected president of the mills. He was the chief factor, through his extraordinary energy and foresight, in the development of one of the largest woolen mills in New England, if not in the world, from the small beginning made in 1867, with limited capital and poor equipment and under divided counsel. Under his general direction, the capitalization grew from $150,000 to $8,000,000, and the number of employees from 300 to 8,900. The mills, all within one yard, afford a floor space of sixty-two acres, the architecture of the mill buildings being acknowledged to be the finest in the world. Within the walls, 1,250,000 pounds of wool can be consumed weekly, equivalent to the fleeces of 33,000 sheep daily. In addition to the consumption of wool, the mills in the cotton department of the corporation consume annually 12,000 bales of raw cotton. This recapitulation of work done seems to be pertinent in any sketch written of Mr. Whitman, as it was his life-work, and his personality was closely woven in every yard of the product of the great mills. He was a pioneer in the worsted industry and created a growth on untouched fields, and, within his memory, the clothing of his father's family and the community in which they lived was woven on the hand loom and the yarn from which it was woven was spun on the old-fashioned spinning-wheel.

From 1895 Mr. Whitman influenced the construction of many new mills in New England, in which he served as managing director. He caused the Whitman Mills, for the manufacture of cotton goods, to be erected in New Bedford in 1895 and 1902, and the Manomet Mills in the same city in 1903 and 1908. The Whitman Mills, during Mr. Whitman's incumbency of the presidency, were capitalized at $1,500,000; equipped with 132,000 spindles and 3,400 looms used in the manufacture of cotton cloths. The Manomet Mills have $2,000,000 capital, 124,000 spindles and produce cotton yarns. The plant of the Nonquit Spinning Company, also in New Bedford, was erected in 1906 and 1910, the corporation having a capital of $2,400,000 and 130,000 spindles; this company confining its product to cotton yarns. The Nashawena Mills, of the same city, organized in 1909 with a capitalization of $2,500,000, with 150,000 spindles and 4,000 looms, for the manufacture of cotton cloths. Mr. Whitman at this writing (1911) is president of the Manomet Mills, Nonquitt Spinning Company and the Nashawena Mills, which with the Arlington Mills represent a combined capital of $14,900,000 and employ over 12,000 opera-

tives. These mills are models of modern American cotton mills. Mr. Whitman in 1887 became a partner in the firm of Harding, Colby & Co., commission merchants, of Boston and New York, the firm being selling agents for the Arlington Mills. The firm was dissolved in 1889 by the death of Mr. Colby, and Mr. Whitman became managing partner of the firm of Harding, Whitman & Co., its successor, and the business of the firm kept pace with the growth of the Arlington Mills and branch offices were established in the leading cities of the country.

On June 30, 1909, the firm of Harding, Whitman & Co. was succeeded by a new firm, William Whitman & Company, with Mr. Whitman as senior and managing partner.

The great businesses of these mills and of this firm of commission merchants did not compass the work done by Mr. Whitman. He took an active and alert interest in the business and industrial development of the country in its larger aspects, and in the political and social questions having a bearing upon the industries in which he was primarily engaged. He was a prominent member of the National Association of Wool Manufacturers, and served as its president in 1888-94; but through stress of business duties declined such services in 1894-1904 while consenting to serve on its executive board. In 1904 he again was chosen president and was re-elected in 1905 and successive years.

In politics he was a staunch adherent of the Republican party, and in that organization he exerted a large influence upon public affairs, especially along the lines of industrial economy and the trade and tariff of the United States. He became an acknowledged authority in tariff matters, especially in connection with the manufacture of woolens and as to the effects of proposed tariff legislation. The textile manufacturers of the United States sought from him expressions of opinion gathered from his large personal experience and his wide and thorough study of the subject of textile manipulation.

He was the author of "Free Raw Materials as Related to New England Industries;" "Free Coal—Would it Give New England Manufacturers Cheaper Fuel?" "Some Reasons Why Commercial Reciprocity is Impracticable;" "Objections to Reciprocity on Constitutional and Practical Grounds;" "What are the Protected Industries?" "The Tariff Revisionist; an Example of the Nature of his Demand," and other papers on economical questions widely circulated and which attracted universal attention. His style is direct, compact and forcible, writing as he does facts gathered from experience to prove his convictions, and not visionary theories but ill-digested. His club affiliations included the Arkwright Club, American Academy of Political and Social Science (life member), Boston Press Club (life member), Bostonian Society, Bunker Hill Monument Association, Chamber of Commerce, Commercial Club, Country Club, Eastern Yacht Club, Home Market Club, Massachusetts Club, Massachusetts Horti-

cultural Society (life member), Manufacturers' Club of Philadelphia, New England Historic-Genealogical Society, Republican Club of Massachusetts, Society of Arts and the Union Club.

Mr. Whitman married, Jan. 19, 1865, Jane Dole, daughter of James Hendricks and Mary Ann (Arnold) Hallett, of Boston, a descendant from distinguished Loyalist families which left New York in 1783 at the close of the American Revolution, and made their homes in St. John's New Brunswick. Eight children were born of this marriage and four sons and three daughters were living in 1910.

THOMAS ST. JOHN LOCKWOOD.

Thomas St. John Lockwood was born in Roxbury, Mass., July 5, 1853, the son of Commodore Samuel and Maria (Dunbar) Lockwood, and a descendant of Robert Lockwood, who came from England in 1630, settled in Watertown, Mass., and later founded the town of Fairfield, Connecticut. The subject of this sketch attended the public schools in Roxbury, and subsequent to his graduation from the Roxbury High School entered the woolen house of E. Allen & Co., Franklin Street, Boston, where he remained for three years and there obtained his early knowledge of the woolen goods business. In August, 1877, he was engaged as clerk by Parker, Wilder & Co., Dry Goods Commission Merchants of Boston and New York, and after some time spent in the Boston office and at one of the mills, in the interest of the firm, he returned to Boston and worked up to the position of salesman, and was admitted to the house as a partner in 1891.

In addition to his connection with Parker, Wilder & Co., Mr. Lockwood was president and director of the Sterling Mills, of Lowell, and also a director of the Union Mills, of Peterboro, N. H., in which his firm is interested, and he declined directorships in a number of corporations. As a member of the Boston Chamber of Commerce, he was appointed a member of its Investing Committee, and he was a trustee of the Eliot Five Cents Savings Bank, a member of the Somerset, Country and Exchange Clubs, Society Colonial Wars, Bunker Hill Monument Association, Bostonian Society and Pilgrim Society.

Mr. Lockwood married, October 14, 1890, Emmeline, daughter of John Ward Gurley and Emmeline (Dabney) Stackpole. Two children were born to them: Dunbar, Oct. 19, 1891, and Grace Stackpole, July 10, 1893.

FRANKLIN WARREN HOBBS.

Franklin Warren Hobbs was born in Roxbury, Suffolk County, Mass., September 24, 1868, son of William and Mary Marland (Cogswell) Hobbs: grandson of William Hobbs and of Francis Cogswell, great-grandson of Abraham Marland and of William Cogswell and a descendant of Josiah Hobbs who came from England to Watertown, Massachusetts Bay Colony, in 1685, and settled in that portion which afterwards became the town of Weston. His maternal ancestor, John Cogswell, came from Bristol, England, in 1635, and settled in Ipswich, Massachusetts Bay Colony. John Cogswell's grandsons, Col. Thomas and Surgeon-in-Chief William Cogswell, of Haverhill, Mass., were prominent men in their day, being two of fourteen sons and five daughters born to Nathaniel Cogswell, and two of the nine sons that reached adult years and two of the eight who joined the Revolutionary army. Thomas, who married Ruth, daughter of Gen. Joseph Badger, was captain of a company in Colonel Gerrish's regiment at Bunker Hill; was major of Colonel Vose's regiment from Feb. 21, 1777, and lieutenant-colonel of the 15th Massachusetts line, Nov. 26, 1779, subsequently serving as wagon-master-general to the close of the war, when he settled in Gilmington, New Hampshire, where he served as judge of the Court of Common Pleas, 1784-1810. His son, Nathaniel (1773-1813), died in Mexico while holding a general's commission in the patriot army in the rebellion of that year, and two other sons, Thomas and Francis, died in the military service of the United States in the second war with Great Britain. William Cogswell (1760-1831), a younger brother of Colonel Thomas, entered his brother's company when fifteen years of age, and having served his term of enlistment, studied medicine and surgery, and, in 1778, re-enlisted under General Sullivan. He was surgeon's mate in the military hospital at West Point, N. Y., 1781-84; surveyor-in-chief of the hospital and chief medical officer of the U. S. Army, 1784-85, and a founder of the New Hampshire Medical Society and of the Atkinson Academy. Mr. Hobbs' maternal grandfather, Francis Cogswell, was a woolen manufacturer, lawyer, and president of the Boston and Maine Railroad, and his great-grandfather, Abraham Marland (*Ibid*), was the founder of the Marland Manufacturing Company, of Andover, Mass. Franklin Warren Hobbs was educated at the Brookline Public Schools and the Massachusetts Institute of Technology, where he was graduated bachelor of science in the department of mechanical engineering, in 1889. He was instructor in mechanical engineering at the Institute, 1889-91, and in 1891 he took a position in the Arlington Mills, Lawrence, Mass., one of the largest textile corporations in the world, employing 8,000 persons and having a capital stock of $8,000,-000 (1911) Mr. Hobbs served his corporation from 1902 as treasurer and executive officer.

Mr. Hobbs was actively identified with the educational, historical,

A. H. Littlefield

religious and benevolent movements, having in charge the public weal of Brookline, and his service as a member of the school committee, its secretary for several years and its chairman as successor to Prentiss Cummings from 1904, is especially appreciated by the parents in Brookline. He was also elected a member of the Educational and Historical societies and a vestryman in St. Paul's Episcopal Church. He was an original trustee of the Lowell Textile School, and by appointment of Governor Crane he was made a State Trustee in 1900. He served as president of the National Association of Cotton Manufacturers, a member of the Executive Committee of National Association of Wool Manufacturers, Trustee of Mt. Auburn Cemetery, vice-president of M. I. T. Alumni Association, director of Arkwright Mutual Fire Insurance Co., Home Market Club, the Riverdale Press, Manomet Mills, and a member of the Council of the Beverly Yacht Club. He was also a member of the following: Union Club, Country Club, Technology Club, Arkwright Club, Chamber of Commerce of Boston, Episcopalian Club, Merrimack Valley Country Club, Massachusetts Club, Sons of the Revolution, Society of Colonial Wars, Eastern Yacht Club, Sippican Yacht Club, the Society of Arts, Old Colony Club and Brookline Republican Town Committee.

Mr. Hobbs married, May 31, 1892, Jane Hallett, daughter of William and Jane Dole (Hallett) Whitman, and their children were: William Whitman, Marland Cogswell, Franklin Warren, Jr., and Rebekah Hobbs.

ALFRED HENRY LITTLEFIELD.

Alfred Henry Littlefield was born April 2, 1829, in Scituate, R. I. He was the son of John and Deborah (Himes) Littlefield, and was of the eighth generation in direct descent from that member of his family who first settled in America, through his grandfather, John Littlefield; Nathaniel and Catherine (Sands) Littlefield; Nathaniel and Margaret (Mitchell) Littlefield; Caleb Littlefield; Francis and Rebecca Littlefield; Edmund and Annis (or Ann) Littlefield. Edmund Littlefield who was born at Tichfield, England, in 1591 or '92, came to New England in 1637, and was of Boston, Exeter, and finally settled in Wells, Maine, where he died Dec. 11, 1661. He was one of the first settlers in Wells and was a commissioner with Wheelwright & Knight. Some members of the family claim that he was a churchman and Royalist who was excluded from Boston for his religious and political opinions.

Francis, his son, was born in Lichfield, England, in 1619. He married (first) Jane, daughter of Ralph Hill, of Plymouth, Mass. She died in 1646, and he married Rebecca (Hill) in 1648. Of Caleb little is said.

Nathaniel, his son, was admitted a freeman in 1721, of New Shoreham (Block Island), R. I., where he was a prominent man, being a representative from his town in the legislature in 1738, 1740, 1746, 1748 and 1754. Nathaniel, his son, was admitted a freeman in 1756. He had a seat in the legislature in 1758 and again in 1762.

Of John, grandfather of Alfred Henry Littlefield, little mention is made. His father, John, had eleven children, several of whom became prominently distinguished, among them the subject of this sketch. John Littlefield removed from North Kingstown, R. I., to Scituate in 1828, and in 1831 to Natick, in the town of Warwick, where he died June 23, 1847.

Alfred Henry Littlefield received a rudimentary course of instruction in the public schools of Natick, in the town of Warwick, R. I., and at the age of eight entered the Sprague Mills and there remained until the fall of 1844, when he again attended school in Natick for six months. In 1845, he became a clerk in the employ of Joseph M. Davis, a merchant of Central Falls, R. I., and he also engaged in a small way in the business of putting up "skein" and "spool cotton." In 1846 or '47, George L. Littlefield, an elder brother of Alfred H., took over the business of Mr. Davis, and took as his partner Elias Nickerson. In 1849, Mr. George L. Littlefield became sole proprietor and his younger brother continued as his clerk until 1851, when George L. Littlefield sold the store, and the firm of Littlefield Bros. was formed to continue the thread business, with stores at Haydenville, Mass., and also at Pawtucket, R. I.

In 1854 the store business was sold out, and George L. and Alfred H. Littlefield formed a partnership with David Ryder, under the firm name of David Ryder & Co., manufacturers of yarns. Later on, the brothers purchased Mr. Ryder's interest, and the business was carried on by them from 1858 to 1889 under the firm name of Littlefield Brothers. In 1889, George L. Littlefield retired from the business and a company was formed and incorporated under the name of the Littlefield Manufacturing Company, of which Alfred H. Littlefield became president, and his sons, Alfred H., Jr., and Eben N., treasurer and secretary respectively. This company is one of the most extensive industries of Pawtucket, the product being cotton yarns and thread. The works are on the west bank of the Blackstone River between the upper and lower dams at Pawtucket Falls.

Alfred H. Littlefield, Sr., was one of the incorporators of the Pawtucket Hair Cloth Company, and one of the directors from its inception in 1861 until his death. He had other business interests and was a director of the First National Bank of Pawtucket, Royal Weaving Company, Pawtucket Gas Company, Pawtucket Street Railway Company.

Mr. Littlefield was prominent in civic and military affairs and attained to the highest dignity in the State. Originally a Whig, he became a Republican on the formation of that party, and during the Civil War was a zealous supporter of the Union cause, and gave frequent and generous

assistance to the families of those who were absent in the field. In 1864, he was appointed Division Inspector of the Rhode Island Militia, with the rank of colonel, and held the office for five years.

His political career was long and varied. From June, 1873, to June, 1877, he was a member of the town council of Lincoln, and in 1876 to 1877 was representative of that town in the General Assembly. In 1878, he was elected a member of the upper house of the State Legislature, and was elected again in 1879. In March, 1880, he was nominated for governor by the Republican party, and at the election he received 10,224 votes against 7,440 votes for the Democratic nominee, Horace A. Kimball, and 5,047 votes for the Prohibition candidate, Howard. As the law requires a majority vote, the election devolved upon the General Assembly, and he was chosen governor by a vote of eighty-two Republicans against twenty Democrats.

In 1881, the total vote for governor was 16,201, of which Governor Littlefield received 10,849; the Democratic candidate, Horace A. Kimball, 4,756; the Prohibition candidate, 825. In 1882, the total number of votes cast was 15,523, of which Governor Littlefield polled 10,056.

Governor Littlefield advised the establishment of a State Industrial School, for pauper and vagrant children, in his message in 1882, and made valuable suggestions tending to the betterment and increased usefulness of the public school system of the State, advocating the introduction of the elementary principles of physics and mechanics, so as to better fit the people for the development of the manufacturing industries of the State. During Governor Littlefield's term of office, the State entertained as its guests the representatives of the French government, who came to this country to attend the Centennial anniversary of the surrender of the British forces at Yorktown.

Alfred H. Littlefield married, February 9, 1853, Rebecca Jane, daughter of Ebenezer and Jane (Padwell) Northrup, of Central Falls, R. I., and had four children; (1) Eben Northrup (See sketch, *Ibid.*); (2) Minnie Jane, died young; (3) George Howard, died young; (4) Alfred H., Jr., who was born in Central Falls, R. I., was educated at Mowry & Goff's English and Classical School, Providence. After leaving school, he was for some time a clerk in the Providence County Savings Bank of Pawtucket, and after that was associated with his father, and upon the death of the latter, in 1893, became president of the Littlefield Manufacturing Company.

On account of ill health, Mr. Littlefield resided for the greater part of the time, in the last few years of his life, in the Adirondacks, and while on the way home from there, he died at Albany, N. Y., August 6, 1907. He married Clara B., daughter of Charles C. Holland, of Central Falls, R. I., there being no issue. Governor Littlefield died at his residence in Broad St., Central Falls, R. I., December 21, 1893. His remains were interred in Swan Point Cemetery, Providence, R. I.

FREDERIC CLARK SAYLES.

Frederic Clark Sayles, was born July 17, 1835, on what is now East Avenue, Pawtucket, R. I. He was the son of Clark and Mary Ann (Olney) Sayles, and was descended through Ahab and Lillis (Steere) Sayles, Israel and Marsa (Whipple) Sayles, Richard and Mercy (Phillips) Sayles, John and Elizabeth (Olney) Sayles; from John Sayles, who is said to have come from England in 1645, and is of record in Providence, 1651. He was a man of property and distinction and filled various public positions. He married, in 1650, Mary, daughter of Roger and Mary Williams. They both died in 1681. On the maternal side, Mr. Sayles was descended through Paris and Marcy (Winsor) Olney; Emor and Amy (Hopkins) Olney; James and Hannah (Winsor) Olney; Epenetus and Mary (Williams) Olney; Epenetus and —— (Whipple) Olney; from Thomas Olney, a native of Hertford, Hertfordshire in England, who came to America in the ship "Planter," and stopped first at Salem, but later was one of the founders of Providence with Roger Williams, Mr. Olney being one of the thirteen proprietors of Providence. Clark Sayles, father of F. C. Sayles, moved to Pawtucket in 1822, and there followed the occupation of a master builder. He also engaged in the coal and lumber trade, being the first man to introduce coal into Pawtucket by vessel; and in the sale and milling of lumber in the South, and was for seventeen years president of the New England Pacific Bank.

Frederick C. Sayles obtained his education partly in the best schools of Savannah, Georgia, where he spent his winters from 1840 to 1845, and in the schools of Pawtucket, the University Grammar School of Providence, and the Providence Conference Seminary of East Greenwich, where he was graduated with honor in 1853. He then began his business career at the Moshassuck Bleachery at Saylesville owned by his brother, William F. Sayles. He applied himself to thoroughly mastering all the details of every department in the great establishment and after laboring faithfully and efficiently for ten years, he was taken into partnership by his brother, Jan. 1, 1863, and the business up to the time of the death of its senior partner, Mr. W. F. Sayles, was styled W. F. & F. C. Sayles. In 1868, the rapid increase of the business and the prospect of a still further increase induced the partners to greatly enlarge their facilities by the erection of the so-called new bleachery under the personal supervision, and according to the plans of Mr. F. C. Sayles. The finishing of lawns and nainsooks, the finer class of cotton goods, were first accomplished in this country at the Sayles Bleachery, in a department established by Mr. F. C. Sayles.

The Lorraine Worsted Mills and the Glenlyon Dye Works were also under Mr. F. C. Sayles' management, and were successful from the outset. The various enterprises of the Sayles Brothers are among the leading industries of New England, and afford employment to about four thousand

F. C. Sayles

people in Pawtucket and the adjacent village of Saylesville, which with its well-kept streets, neat houses, its railroad facilities and its beautiful memorial church, is a lasting monument to the founders from whom it takes its name. On the death of W. F. Sayles, the various enterprises developed with such great success by the brothers were reorganized into three separate companies. Frank A. Sayles, the son of W. F. Sayles, inherited his father's interest in the business and in 1896 purchased his uncle's interest in the bleachery property, the Glenlyon Dye Works, the Lorraine Mills, and the Crefeld Mills at Westerly. In 1900, Mr. F. C. Sayles organized the Baltic Mills at Baltic, Conn., and erected one of the handsomest mill buildings in New England. He was president of the company from its organization until his death, when his son Frederic Clark Sayles (2) succeeded him.

Mr. Sayles was connected with several business enterprises, in which he held various offices. He was the first president of the Pawtucket Business Men's Association, and served for four years in that capacity. In 1885, when the charter of the city of Pawtucket was adopted, he became its first mayor and gave such general satisfaction in that capacity that he was re-elected for a second term of office in 1886, and declined a third election in the following year.

During the last twenty years of his life, Mr. Sayles gave full vent to his hobby of raising race horses and at Mariposa farm, which he owned at the time of his death, he collected as wonderful an assemblage of fast trotting mares and dams of trotters as ever belonged to a single owner Later on he also secured the son of Campbell's Electioneer, Symvoleer, whose record of 2.11 as a two-year-old, was the best made in its time. Other noted horses at the farm included Sable Wilkes, Consuelo S., Wiseburn, Hand Spring, and Alix, queen of the turf. Mr. Sayles at great expense brought together a splendid collection of brood mares, and horsemen far and near prized the colts raised at Mariposa, whose entries at numerous horse shows have been conspicuous as prize winners.

Mr. Sayles was ever ready to encourage and give pecuniary assistance to every worthy cause, either of education, temperance, or religion. He gave to the city of Pawtucket the Deborah Cook Sayles Memorial Library, a noble edifice which was formally dedicated and officially presented to the city in the fall of 1902. He was an extensive traveller, and visited all the principal cities of England, Scotland, Ireland, France, Germany, Austria, Belgium, Holland, Russia, Norway, Switzerland, Sweden, Denmark and Italy, and also visited Mexico and the Pacific Coast.

Mr. Sayles married, October 16, 1861, Deborah Cook Wilcox, and had five children: (1) Caroline Minerva, born January 16, 1866, married (first) Frederic William Holls, of Yonkers, N. Y., and (second) October 2, 1906, Albert Percival Chittenden; (2) Frederic Clark, born August 21, 1868, was graduated from Amherst in the class of 1890, became vice-president and

treasurer of the Baltic Mills Co., with mills at Baltic, Conn., and a director in the Merchants' National Bank, succeeding his father in that capacity. He married Mary Lamper, daughter of Barton E. Kingman, of Yonkers, N. Y., and had five children: Helen Kingman, Frederic Clark, Jr., Caroline Alden, Mary Gardner and Barton Kingman; (3) Benjamin Paris, born October 31, 1871, died May 30, 1873; (4) Robert Wilcox, born January 20, 1878, attended Andover Academy, was graduated from Harvard in 1901, became secretary of the Baltic Mills Company; married, June 1, 1904, Adelaide Kimball Burton and had one child, Deborah Wilcox, born February 23, 1906; and (5) Deborah Wilcox, born November 17, 1880; married, June 14, 1905, Rev. Fred Burnett Hill.

Mr. Sayles died at his home at Bryn Mawr on East Avenue, Pawtucket, R. I., January 5, 1903, and was buried in Swan Point Cemetery, Providence.

LEANDER R. PECK.

Leander R. Peck was born at Barrington, R. I., February 12, 1843, son of Asa and Lucretia (Remington) Peck. He was educated in Barrington, in the High School at Warren, under Professor Cady, and at East Greenwich Academy, February 14, 1860. At the age of seventeen, he removed to Providence, Rhode Island, and accepted a position as clerk in the fancy dry goods and milliner's store of his uncle, Jeremiah S. Remington, remaining with him in this capacity for three or four years.

In 1866 the firm of Asa Peck & Co. was formed, for the purpose of buying and selling woolen waste, shoddies, etc. At that time, this particular line of business was comparatively new to Rhode Island, and all previous attempts to make a success of it had failed. Leander R. Peck, however, had become thoroughly imbued with the idea that there was a promising future in store for such a company, and time proved the truth of his theory. For the first year or so, as with many new ventures, the issue was doubtful at times, but eventually its success became assured, and it is no disparagement to anyone else connected with the firm to state this success was in a very great measure due to his personal efforts and keen insight into the business of the company, directing its policy, and assuming those duties which called for marked executive ability. The members of the firm were: Asa Peck, with Leander R. Peck, until 1878, when the late Walter A. Peck became a member. Asa Peck retired some years before his death, and Walter A. in 1899. On Jan. 1, 1903, the firm was incorporated, under the name of Asa Peck & Company, Incorporated, the officers being: Leander R. Peck, president and treasurer; Frederick S. Peck, assistant treasurer and secretary (became treasurer); G. Howard Smith, vice-president; W.

Leander Peck

H. Cannon, auditor; and Walter F. Seymour, director. The firm, besides being the first of its kind in the State of Rhode Island, became long ago the leading one. Mr. Peck was president of the Lawton Spinning Co., at one time a director of the Union Trust Co., of Providence, and its vice-president. He was also director of numerous other financial corporations of this city, and filled an important place in the commercial life of the county and State.

Mr. Peck's pride and delight was his home in Barrington, known as the Osamequin Farm, where he spent his summers. The land was deeded by the Indians to one of his ancestors, in 1653, and has never been out of the family. It contains more than two hundred and fifty acres, and is rightly pointed out as a "model farm." One of his specialties was orchids, his greenhouses containing over three thousand species; another was trotting horses. In 1899 was begun a collection of copper and silver lustre which became the finest in the country. He bought the ground and started the Pomhan Club, and was for some years, early in its history, chairman of the Executive Committee, and then its president.

In politics he was an Independent Democrat, and for four years was a member of the Council in the City of Providence. He was also a member of the Board of Trade, and at the time of his death a member of the Barrington Town Council. He belonged to various clubs.

September 3, 1866, Mr. Peck married Sarah Gould Cannon, born April 25, 1844, daughter of Charles and Mary P. (Fisher) Cannon, the former of Newport, R. I., and the latter of Edgartown, Mass. They had two children: 1, a son, Frederick Stanhope, born Dec. 16, 1868, married, June 6, 1894, Mary Rothwell, born June 30, 1873, daughter of Edwin H. and Eliza (Aylsworth) Burlingame; they had one child, Helen, born Dec. 22, 1895, in Providence. 2, a daughter, Edith Remington, born March 14, 1874, who married, November 15, 1898, Frank N. Phillips, president of the American Electrical Works, East Providence. They have one daughter, Charlotte, born Jan. 3, 1903. Leander R. Peck died in Providence, R. I., Jan. 28, 1909.

ALBERT GREENE DUNCAN.

Albert Greene Duncan was born in Cleveland, Ohio, December 12, 1868, son of the Rev. Dr. Samuel White (1838-98) and Sarah Margaret Fuller (Greene) Duncan; grandson of Hon. James Henry (1793-1869) and Mary (Willis) Duncan and of Judge Albert Gorton and Mary (Clifford) Greene, of Providence, Rhode Island; great-grandson of James and Rebecca (White) Duncan; great-(2)-grandson of James (who settled in Haverhill, Mass., in 1740) and Elizabeth (Bell) Duncan; great-(6)-grandson of George Duncan of the Scotch-Irish Colony of Londonderry in the North of Ireland,

who settled in Londonderry, New Hampshire, in 1719. He was also descended from John Greene, who with Samuel Groton came from Salisbury, England, to Boston, Massachusetts Bay Colony, in 1635, and later became an original settler of Warwick, founding that town and serving the community as deputy governor of the province. Another immigrant ancestor was William White, who came from England in 1635 and was the first settler of Ipswich, Massachusetts Bay Colony. His grandfather, James Henry Duncan, was graduated from Harvard, A. B., in 1812, was a representative in the Massachusetts legislature five years, a State Senator two years, member of the executive council and a representative for Massachusetts in the thirty-first and thirty-second Congresses 1849-53, and his maternal grandfather, Albert Gorton Greene, of Providence, R. I., was the author of "Old Grimes." His father, Dr. Samuel Duncan, was pastor of the Euclid Avenue Baptist Church, Cleveland, Ohio, from 1867 to 1875.

Albert Greene Duncan was prepared for college at Phillips Academy, Andover, Mass., and was graduated from the University of Rochester A. B. in 1891. He became a draughtsman in the construction department of Westinghouse, Church, Kern & Co., working for both the Boston and New York houses as draughtsman and constructing engineer, 1891-98, when he became treasurer of the Deane Steam Pump Company, Holyoke, Mass., 1898-1900. In 1900 he resigned, to accept the position of assistant treasurer of the Dwight Manufacturing Company at Chicopee, Mass., and in 1903 transferred his services to the Chicopee Manufacturing Company, Chicopee Falls, Mass. In 1909, Mr. Duncan accepted the presidency and treasurership of the Harmony Mills, located at Cohoes, N. Y., and managed that mill as well as the Chicopee Manufacturing Co. He continued his profession of engineering, devoting much time to the development of electrical transmission of power for textile mills, and was elected, in May, 1909, a member of the American Society of Mechanical Engineers.

WALTER H. SUMMERSBY.

Walter Henry Summersby, born in Pembroke, N. H., June 18, 1857, was the son of William and Susan (Wall) Summersby. William Summersby was a civil engineer in Pembroke, and the subject of this sketch remained in his native town until he reached his majority. He attended the public schools, later taking a course at the Pembroke Academy, and subsequent to his graduation, entered the Pembroke Textile Mills, in which he had, during vacation times, worked since his tenth year. Starting in the mule room, he went through each department until he finally worked as weaver. At the age of twenty-one he left these mills to take charge of a

Walter H. Summersby

section of looms in the China Mills at Suncook, N. H., where he remained until March, 1880. He then went to Newmarket, N. H., as a loom fixer, and in a comparatively short time was promoted to the position of overseer in the mill.

In order to procure a broader knowledge of manufacturing conditions and the various methods of conducting trade, Mr. Summersby realized that he must not confine himself to one particular place. He consequently went to Fall River, where he secured a position in the Montaup Mills, later known as the Osborne Mill, and, after assisting in improving the conditions here, he left in 1884 to take charge of the weaving department of the Arctic Mills, Arctic, R. I., where he worked with great success until 1886. He next went to work in the St. Croix Mill, Milltown, N. B., and later superintended the White Rock Mill at Westerly, R. I., which latter position he held for seven years. He then went south to superintend a cotton mill in Henderson, Ky. After a year's service here, he returned north to become agent for the Pontiac Mills & Bleachery, Pontiac, R. I. While in Pontiac, he served that town as postmaster for five years and also officiated acceptably on the Board of School Trustees for a like period.

In 1901, Mr. Summersby resigned his position with the Pontiac Mills & Bleachery in order that he might become agent of the Atlantic Cotton Mills, Lawrence, Mass. Great responsibilities were attached to this new position, for into his hands was given the reconstruction of the property. Undaunted, he set to work, step by step remodeled, furnished and made over the plant, and under his supervision the new weave shed, known as No. 5 Mill, was erected, and the first loom started Good Friday, April 17, 1908. He also built a brick cotton storehouse that would hold a year's supply of cotton. The results obtained through his unremitting and skilful efforts afforded much gratification to the owners of the Atlantic Mills, for in an incredibly short time he had brought the mill back to a satisfactory dividend basis.

Mr. Summersby was a director in the Lawrence Savings Bank, was a member of the Board of Trade, Textile Club, and of many fraternal organizations, including the Masons, Knights Templar, the Shriners and the Odd Fellows. He was also interested in the Lawrence Industrial School, and as a trustee of that institution gave great encouragement to the progression of its work.

Mr. Summersby married, April 26, 1888, Etta Frances, daughter of Calvin H. and Sarah (Dore) Weymouth, and had issue of four children. One son, George W., at this writing (1911) is in charge of the designing and dressing department of the Atlantic Cotton Mills.

Walter H. Summersby died in Lawrence, Mass., June 23, 1910, his wife and children surviving him.

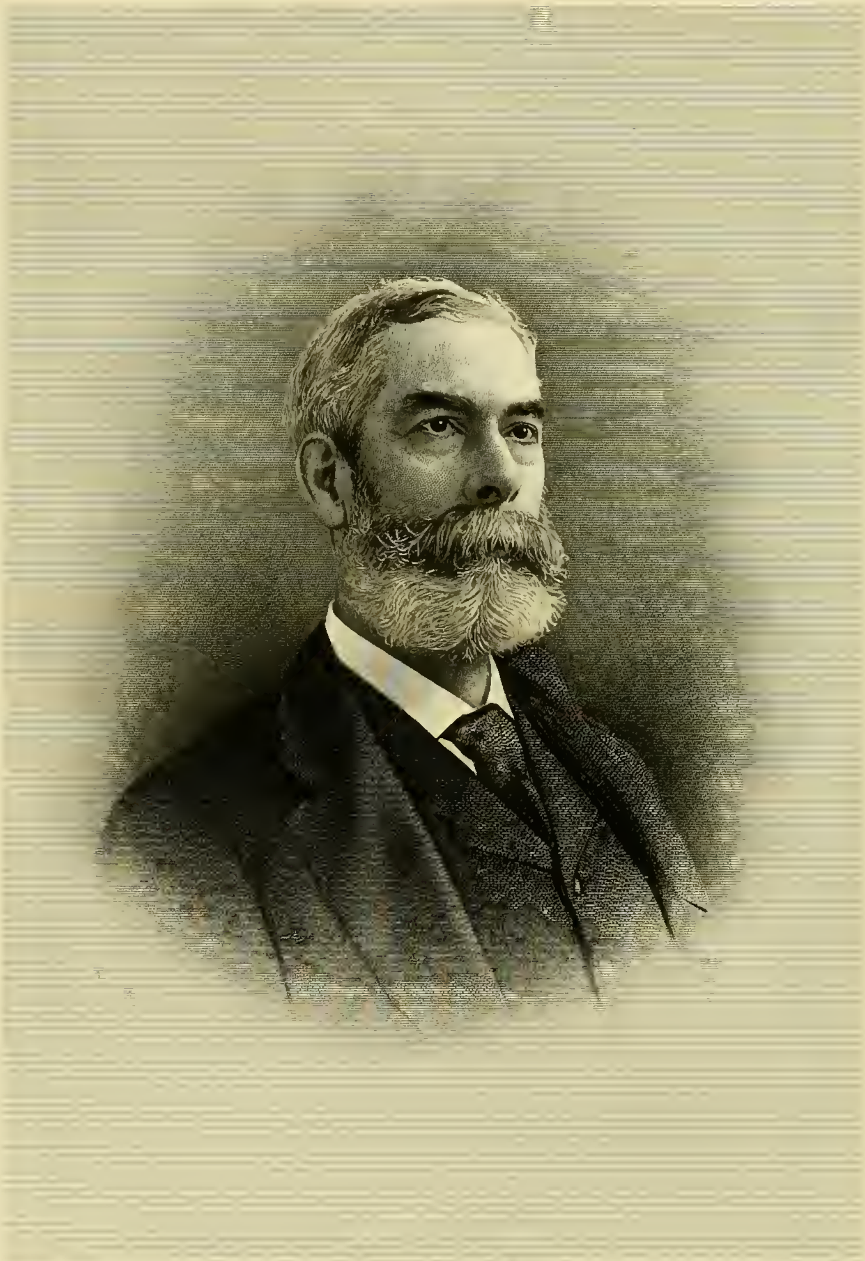
JAMES SULLIVAN AMORY.

James Sullivan Amory was born in Boston, Mass., May 14, 1809; son of Jonathan and Mehitable (Sullivan) Cutler Amory; grandson of Thomas and Elizabeth (Coffin) Amory and of Gov. James Sullivan, the fifth governor of Massachusetts; and a descendant through Thomas and Rebecca (Holmes) Amory; Jonathan (1653-99) and Rebecca (Houston) Amory; Thomas (1608-67) and Ann (Elliott) Amory; from Hugh Amory, of Wrington, Somersetshire, England, and of Robert Elliott, of Bristol, England. Jonathan (1653-99) was the first of the family in America and he came by way of Dublin, Ireland, and the Barbadoes, West Indies, and settled in Charleston, South Carolina, about 1691, where he was speaker of the Assembly, advocate general and treasurer of the province. His son, Thomas, was also an immigrant, accompanied his parents to the Barbadoes, but was educated in England, was a merchant at Augra, in the Azores, where he was consul for the English and Holland governments, and in the year 1719, returned to Charleston by way of Boston, and in 1720 settled in Boston as a merchant. His son, Thomas, was graduated from Harvard in 1741. He studied theology, but became a merchant. He had nine children, and the third, Jonathan, was graduated from Hárvard in 1787, and became a clerk in the business house of his uncles, Jonathan and John Amory, engaged in business with James Cutler and later with his elder brother, Thomas Coffin Amory.

Jonathan's third child, James Sullivan Amory, attended the private school of Captain Partridge near Boston, passed two years at Harvard College and received his A. B. degree out of course. James Sullivan Amory made two trips to Calcutta as supercargo and frequent visits to Europe. He was treasurer of the Nashua Manufacturing Company and of the Jackson Company, of Nashua, N. H., manufacturers of cotton goods, and of the Lancaster Mills, of Clinton, Mass. He also served as president of the Provident Institution for Savings and as a director in various business enterprises. He served in the Massachusetts Volunteer Militia as colonel of the Independent Corps of Cadets.

Mr. Amory married, November 28, 1837, Mary Copley, daughter of Gardner and Elizabeth (Clark) Greene, and their son, Robert Amory, born May 3, 1842, was a noted physician and author in Boston for many years and subsequently president of the Brookline Gaslight Company.

James Sullivan Amory died in Boston, Mass., June 8, 1884.



Arthur Amory

ARTHUR AMORY.

Arthur Amory was born in Boston, Mass., Feb. 6, 1841; son of James Sullivan and Mary Copley (Greene) Amory. (See sketch of James Sullivan Amory, *Ibid*). He was educated at the Latin school of Epes S. Dixwell, of Boston, and at Harvard University, graduating in 1862 and receiving the degree of A. M. in course. The year following his graduation he entered the employ of the dry goods commission house of Slade & Colby, N. Y. The firm dissolved in 1866 and he accepted a partnership in the commission house of Upham Tucker & Co., selling agents for several extensive New England cotton mills, the firm being a branch of the old Boston house of the same name established about 1828.

In 1877, Mr. Amory removed to Boston to become a partner in the parent house, and in 1891 the firm became Amory, Browne & Co., with Mr. Amory as senior partner. In 1897 Mr. Amory became interested in the manufacture of cotton, and he directed the establishment of the Indian Head Mills, of Alabama, situated at Cordova, Alabama, and he was made president of the corporation, a position which he still held in 1911. He likewise served on the directorate of the Old Boston National Bank, which was established in 1803. In conjunction with Albert C. Haseltine, James H. Fay, Chas. F. Fearing and Dr. G. Perry, Mr. Amory, while in New York, organized the Harvard Club in 1866.

Mr. Amory married Elizabeth, daughter of Charles Ingersoll, of Philadelphia, and had three sons and two daughters.

WILLARD LOVERING.

Willard Lovering was born in Holliston, Mass., Nov. 18, 1801. He was the son of William and Mehitable (daughter of Samuel and Mary (Bullard) Claflin, of Framingham, Mass.), grandson of Thaddeus and Elizabeth (Littlefield) Lovering, and a descendant of William Lovering from the parish of Oldham, County of Suffolk, England.

Willard Lovering was brought up on his father's farm and attended the district school, obtained a schoolteacher's certificate and taught school. He continued at that occupation, however, only a short time, having determined to learn the business of cotton manufacturing. To this end he found employment in the City Cotton Mills at Franklin, Norfolk County, Mass., where he obtained rapid advancement and was given entire charge of the mills. The Blackstone Canal Corporation of Providence, Rhode Island, learning of his skill and executive ability as a manufacturer, gave him entire charge and made him collector in 1830, and in 1833 he resigned to

become agent of the Carrington Mills, at Woonsocket, R. I. In 1836 he became part owner and manager of the Whittenton Mills, at Taunton, and he operated that mill successfully for twenty years; but in 1857 the failure of C. H. Mills & Company, his partners, and the principal owners of the mills, forced the concern into liquidation, and in 1858, he, with his son, Charles L. Lovering, purchased the property.

In 1864 ill health forced him to retire, and his sons, Charles L., William C. and Henry M. Lovering, assumed entire charge of the business of the Whittenton Mills, and in 1883 incorporated the Whittenton Manufacturing Company with a capital of $600,000, with W. C. Lovering as president, Charles L. Lovering, treasurer, and Henry M. Lovering, agent and clerk.

Willard Lovering was a charter member and the first president of the Taunton Savings Bank, organized in 1869; president of the Taunton Branch Railroad, and a director in the Machinists' National Bank. He served the Commonwealth of Massachusetts as a representative in the General Court, 1865-66, and as a citizen of Taunton he was interested in the welfare of the city, was a leader in measures for the betterment of the largely increasing population, drawn to the place by the various growing industries centred there, and a member and officer in St. Thomas Protestant Episcopal Church. Mr. Lovering married (first) Nov. 13, 1831, Susan Loughead, of Warren, R. I., and they had two children; (second) Sarah Cary Morton, daughter of Gov. Marcus Morton, and they had two children. Mr. Lovering died in Taunton, Mass., Dec. 15, 1875.

CHARLES LOUGHEAD LOVERING.

Charles Loughead Lovering was born at Woonsocket, R. I., Aug. 31, 1833; son of Willard and Susan (Loughead) Lovering. (For genealogy see sketch of Willard Lovering.) He was educated in the public schools at Taunton, Mass., and at Webster School, Cambridge, Mass. He received his early training in mill management at the Whittenton Mills, at Taunton, Mass., of which his father was superintendent and part owner; and in 1858, when the failure of C. H. Mills Co., his father's partners, caused the liquidation of the firm, Charles L. joined his father in the purchase of the business which under their management soon regained a firm and prosperous condition. In 1864 his father retired, and Charles L. with his brothers, William C. and Henry M. Lovering, assumed entire control of the Whittenton Mills; in 1883 they were incorporated as the Whittenton Manufacturing Company with Charles L. as treasurer.

Later in life his constructive genius found full scope in larger enterprises, including the Massachusetts Mills and Merrimack Manufacturing

Company, of Lowell. When cotton was booming in the Southern States, he conceived the plan of establishing mills there, as branches of the Massachusetts Cotton Mills, of Lowell, of which he was treasurer; and was instrumental in establishing the Massachusetts Cotton Mills at Lindale, Ga. Many of the directors of the Massachusetts Cotton Mills were strongly opposed to these plans, but he persisted in putting them into operation, and their feasibility was proven by the eminently successful results, the Georgia Mills becoming valuable assets of the Northern corporations.

When the consolidation of the American Felt Mills, having their headquarters in New York City, with manufacturing plants at Glenville, Conn.; Franklin, Norfolk and Rockville, Mass.; Picton, N. J., and Dolgeville, N. Y., was under advisement, Charles L. Lovering was unanimously chosen as the fitting person to assure the success of the consolidation, a choice which he amply justified. He was treasurer of the Massachusetts Cotton Mills from 1890; of the Merrimack Mfg. Co. 1900; of the Whittenton Mills; of the Massachusetts Mills in Georgia, from its incorporation in 1894, and of the American Felt Company; a director of the Elizabeth Pool Mills and the Gosnold Mills, director of the Old Colony R. R. Co., a trustee of the Boston Terminal; vice-president of the Massachusetts Hospital Life Ins. Co. and a member of the corporation of the Massachusetts Institute of Technology.

Mr. Lovering married Sarah R. Maltby and had six children, three of whom survived him—a daughter, Susan L., and his sons, Edward, who succeeded him as treasurer of the Massachusetts Cotton Mills in Lowell, Mass., and Lindale, Ga.; and William, manager of the Taunton Dye Works and Bleachery.

Charles L. Lovering died at his home at Taunton, Mass., May 1, 1908.

WILLIAM C. LOVERING.

William C. Lovering was born in Woonsocket, Rhode Island, Feb. 25, 1835; the son of Susan (Loughead) and Willard Lovering. (See sketch of Willard Lovering, *Ibid.*). When William C. was two years of age, the family moved to Taunton, Mass., where the father became part owner and manager of the Whittenton Mills. The subject of this sketch was educated in the grammar and high schools of Taunton, and upon graduation from the latter took a course in Cambridge, Mass. Attaining his twenty-first year, he became clerk under his father in the Whittenton Mill. Naturally studious and enterprising, William Lovering began to familiarize himself with the working of every department from the picker room to the weaving room, and gradually acquired a knowledge of every piece of machinery installed

therein, being able to dissect and put the same together again. From one hundred and twenty looms the equipment of the Whittenton Mills grew to 1,600 looms, William Lovering being one of the principal developers of the business, and in 1883 he was elected president of the company. He did not confine his interest to the Whittenton Mills, but in course of time became affiliated with nearly every cotton manufacturing and yarn industry in Taunton. He was pecuniarily interested in the Cohannet Yarn Mills, Westville Mill (a branch of the Whittenton), Elizabeth Pool Mill and Canoe River Mills, being instrumental in the building of the two latter.

In political and public affairs, Mr. Lovering was also actively interested. He served seven times as Congressman, and figured prominently in the discussion of questions placed before the House. In 1874 he was prominent in the State Senate in the matter of repealing the resolutions of Charles Sumner. He made a special study of the currency question and advocated most strongly the bill prohibiting trading in futures, especially referring to cotton. For two years he was president of the New England Cotton Manufacturers' Association and also of the Arkwright Club. He was a delegate to the Chicago Convention from his district, when Garfield was nominated, and presided over the presidential delegate convention in Boston, in 1892. Mr. Lovering was president of the American Mutual Liability Insurance Co., and was for many years president of the Bristol County Agricultural Society. He was a member of the Grand Army of the Republic, having served as quartermaster of the Second Massachusetts Brigade, comprising the Third and Fourth regiments, during the Civil War.

June 9, 1863, Mr. Lovering married Mary Loring, daughter of Albert E. and Phebe (Loring) Swasey, of Taunton, and three children were born to them. Mr. Lovering died February 4, 1910, and was survived by his three children, his wife having died September 4, 1881.

HENRY MORTON LOVERING.

Henry Morton Lovering was born in Taunton, Bristol County, Mass., July 28, 1840; son of Willard (1801-75) and Sarah Cary (Morton) Lovering; grandson of William and Mehitable (Claflin) Lovering, of Holliston, Mass., and of Governor Marcus and Charlotte (Hodges) Morton, of Taunton, Mass., and a descendant on his father's side from Robert Lovering and Griffin Craft, and on his mother's side from George Morton, or Mourt, financial agent of the Plymouth Colony, born in Yorkshire, England, 1585, married, in 1612, to Juliana, daughter of Alexander Carpenter, arrived in Plymouth in the ship "Anne" in June, 1623, and was the author of "Mourt's

ENG BY E G WILLIAMS & BRO NY

Woodbury K. Dana.

JAMES H. LAMB CO.

Relation," which was published in 1622, and gives the earliest account of the Pilgrim enterprise.

Henry Morton Lovering was brought up in the town of Taunton, where he was fitted for college at Bristol Academy. He was graduated from Brown University, A. M., 1861, and entered the office of the Whittenton Mills as clerk in the same year. In January, 1883, on the incorporation of the business of the Whittenton Cotton Mills as the Whittenton Mfg. Co., he was made agent and clerk and subsequently assistant treasurer of the corporation. He was also a promoter, director and treasurer of the Taunton Street Railway Company, organized in 1871, with a capital of $40,000. He was a member of the board of water commisioners, from 1880, and president of the board from 1894. He also served as chief marshal of the celebration of the two hundred and fiftieth anniversary of the founding of Taunton, June 4 and 5, 1889. He was president of the Old Colony Historical Society from 1905; president of the Taunton National Bank from 1900; trustee of the Taunton Savings Bank; president of the Taunton Dye Works and Bleachery from 1893; treasurer of the Elizabeth Poole Mills from 1903; president of the Taunton-New Bedford Copper Company from 1898, and assistant treasurer of the Whittenton Manufacturing Company from 1900.

Mr. Lovering was elected a member of the Union Club, of Boston, in 1887, and was prominent in the social life of his native city, as he was in its educational, commercial and political welfare. A member and senior warden of the St. Thomas Episcopal Church, Taunton.

He married, June 26, 1864, Isabel F. Morse, daughter of Jason and Hannah Morse, of Taunton; and five children were born of the marriage: Edith L. (Merrick); Mabel L. (Hathaway); Charlotte Morton; and Dorothy; Henry Morton, Jr., died July 25, 1898.

WOODBURY KIDDER DANA.

Woodbury Kidder Dana was born in Portland, Maine, June 7, 1840. He was the son of Luther and Louisa (Kidder) Dana, and a direct descendant of Richard Dana, who came from England to Massachusetts Bay Colony in 1640, and became a freeman of Cambridge. Ephraim Dana, the grandfather of Woodbury K., died at Natick, Mass., November 19, 1792. He was a farmer, selectman of his town, and served as a lieutenant in the Continental Army during the Revolution. The youngest of his eight children was Luther, the father of Woodbury. Luther Dana was born April 10, 1792, went to Portland, Maine, when but sixteen years of age, and was for four years one of the foremost merchants of that city,

Dana Street being named in his honor. His beautiful colonial residence in State Street is still standing. He was a soldier in the War of 1812, and upon returning home joined the militia. He was commissioned Ensign, March 30, 1820, became captain, and resigned April 26, 1825. The first commission signed by Governor King, the first governor of Maine, was that of Notary Public for Luther Dana. Of the nine children of Luther and Louisa (Kidder) Dana, five were living in 1907.

The subject of this sketch was educated at the Portland High School and Lewiston Falls Academy. When but nineteen years of age, he started manufacturing cotton warps at North Gray, Maine, and from then on, with the exception of the time spent in the army, he devoted his life to building up the business now controlled by the Dana Warp Mills.

The grandson of a Revolutionary soldier, the son of a veteran of the War of 1812, it was foreordained that Mr. Dana should respond to Lincoln's call for troops. On August 12, 1863, he enlisted from Androscoggin County, Maine, for three years, or during the war, and was mustered into service as a private in Co. K. 29th Me. Vol. Inf., Colonel George S. Beal commanding. The regiment reported to Gen. N. P. Banks at New Orleans, Feb. 16, 1864, was assigned to the Second Brigade, First Division, 19th Army Corps, and saw active service on the Red River Expedition, was engaged at Sabine Cross Roads, Mansfield, Pleasant Hill, Cane River. Alexandria, Mansura, and in other important battles. During most of his service Mr. Dana was detailed as Ordancè Sergeant, and in the Commissary Department, becoming corporal and later Hospital Steward. He was honorably discharged August 22, 1865.

In 1866 Mr. Dana with a partner began the manufacture of cotton warps at Westbrook, Maine. The partner withdrew and Mr. Dana carried on the business alone, producing warps which found a ready market. In 1892 he caused the business to be incorporated as the Dana Warp Mills, and has been its treasurer and general manager from that time. (For a full history, see Dana Warp Mills in this volume.)

His son, Philip, was graduated from Bowdoin College in 1896, and became superintendent of the mills; Luther was graduated from the same institution in 1903, and became assistant superintendent. Both sons, in 1910, knew the business as it is possible for only those to know it who have unlimited opportunity and every incentive to excel. Doubtless not a little of the remarkable success which has attended the business of Dana Warp Mills, during the last few years, has been due to the intelligent and cordial co-operation of father and sons in promoting the interests of the concern.

Active as was the life of Woodbury K. Dana, he found time for much besides his business of making warps well. Besides the welfare of his family, three things have always been cherished by him; the church, the public schools and the municipality. In the affairs of the city, Mr. Dana always took an active interest; he was for many years an influential member

of the Republican City Committee; was for three years a member of the city council, and for one year its president. When the question of a general sewerage system arose, he had public lectures on the subject delivered at his own expense by a prominent physician of Portland. He was the first to light the city with electricity, but later sold the plant. He was a member of the committee on building public schools, a trustee of the Thatcher Grammar School Fund, and a member of the Walker Memorial Library. In 1904 he was delegate from Maine to the Republican National Convention, which nominated Roosevelt. He is (1911) vice-president of the Home Market Club, of Boston; also a member of Ancient Landmark Lodge of Masons of Portland, and of St. Albans Commandry and a Grand Army man.

Mr. Dana married, Aug. 22, 1869, Mary Littlehale Pickard, and they had seven children.

BENJAMIN FRANKLIN SHAW.

Benjamin Franklin Shaw was born in Monmouth, Maine, Nov. 22, 1832; son of Moses and Martha J. (Hoag) Shaw; grandson of Asa and Susa (Webster) Shaw, and a descendant from Roger Shaw, the immigrant, who appeared early in Cambridge and Watertown, Massachusetts Bay Colony, and removed to Hampton, New Hampshire Grants, in 1647. Served as deputy from Hampton in the General Court of the Colony for several terms. The family were originally from Scotland. Moses Shaw was a skilled mechanic, carpenter and builder, and removed with his family, in 1841, to Topsham, on the Androscoggin River.

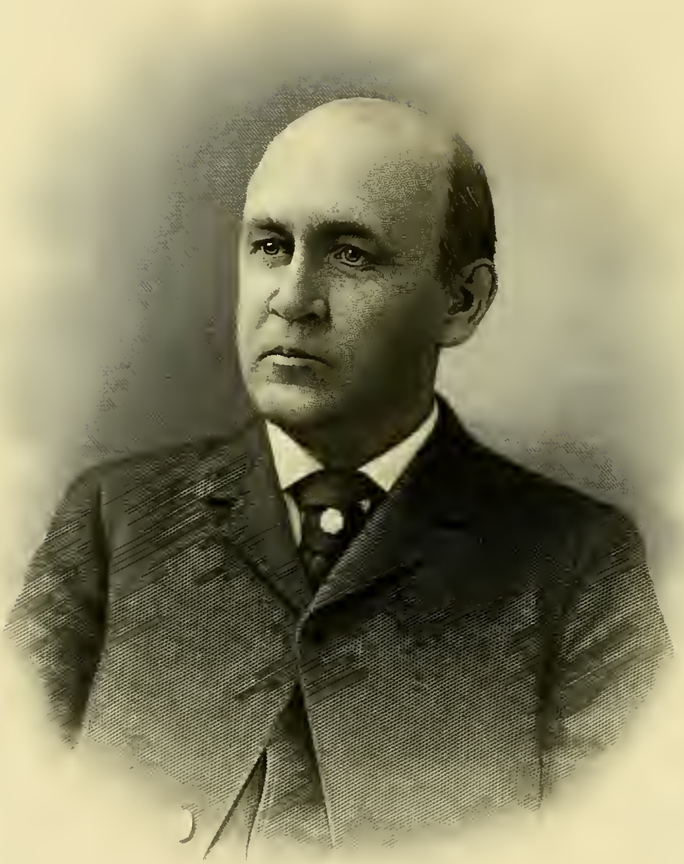
Benjamin Franklin Shaw, who was so well informed as to be thought by many to have been educated at college, was very nearly a self-taught man. His schooling was limited to the winter sessions of the district school and a term at the Academy at Topsham.

In 1850 he took a position in a book store in Brunswick, Maine, and about a year later became bookkeeper in a lumber yard at Gardiner, Maine. On reaching his majority in November, 1853, his employers, at Gardiner, sent him to Philadelphia as their agent. This agency he renounced in 1854 and found employment in the publishing house of Lippincott, Grambo & Co., subsequently J. B. Lippincott & Company, where his advancement was rapid. In 1859 he built a home in Fisher's Lane, Germantown. He prepared a Primary Geography to which for business reasons he appended the name of Fordyce A. Allen, the principal of the Chester County Normal School, who had carefully examined and approved the work. This success was followed with a "Comprehensive Geography" which was published

in 1864, as the work of Benjamin F. Shaw and Fordyce A. Allen. His health becoming impaired, he gave up his position in the publishing house in Philadelphia, sold his home in Philadelphia and removed his family to South Danvers, Mass., where he purchased a new home. He went to Kansas in 1864 where he found in the wild life on a cattle ranch at Salina no attractions for a permanent residence, and, in 1866, he returned to Massachusetts with renewed health. Dr. J. C. Ayer & Co., of Lowell, upon Mr. Shaw's return, made him general manager of outside operations for the firm, including investments. While thus employed, he invented the seamless stocking, and an automatic loom, which was the first circular knitting machine ever produced, capable in itself of producing a stocking without seams, having a rounded heel and toe. He patented the seamless stocking April 23, 1867, and then laid both inventions aside, not being fully satisfied with them, but intending to perfect them at a later time. He resigned the position with Dr. J. C. Ayer & Co., sold his home in South Danvers, and removed to Cambridge, where he devoted his time to his great inventions and to literary pursuits. In 1876, during a visit to Lowell, he met his long-time friend, Earl Amri Thissell, and acquainted him with his financial condition, and the impossibility of placing his loom in operation. Mr. Thissell at once came to his aid, and in 1877 Mr. Shaw had perfected his inventions and produced what afterwards became known as the Shaw-knit Stocking with gusseted heel and instep. This stocking was patented February 12, 1878, and thirty years' use has proved it to be the best fitting stocking art could produce. The stocking and loom perfected, Mr. Shaw exhibited the latter in Lowell, where he then resided, and the exhibition resulted in the corporation of the Shaw Stocking Company, with a capital of $30,000. In 1878 the company was operating eight looms, employing twenty-four persons, and in 1879, and repeatedly thereafter, the capital stock was increased, and new looms and subsidiary machinery were added to the equipment, Mr. Shaw managing the enterprise up to his death in 1890, at which time the capital stock was $360,000, when 275 looms were in operation, and nearly five hundred persons were on the pay-roll of the company.

In 1879 he purchased 500 acres of land surrounding the famous Ossipee Falls in Moultonborough, N. H., and he converted the wild acres into "Ossipee Mountain Park," which was thereafter his summer home. In 1880 he exhibited his loom in England and Germany, first patenting it in London, and selling the right to manufacture the Shawknit stocking to an English corporation known as the London & Leicester Hosiery Co., Ltd., for $75,000. Mr. Shaw was a member of the Masonic order.

He befriended the two orphan children, Mamie and Lizzie Cole, daughters of Jack Cole, a seaman, who lost his life in the expedition of the "Jeannette" to the Arctic regions, gave them employment at his mill, and had them at his summer home. He interested himself in their future



F P Sheldon

welfare by his efforts to procure aid for them from the United States Government, an assistance due to the children made orphans by the extraordinary suffering of their father in the government service.

Mr. Shaw married, Jan. 20, 1853, Harriet Nowell Howard, a native of Haverhill, Mass. Their children were: Charles Franklin Shaw (deceased); Addie Francis Shaw (deceased); Clifford Franklin Shaw; Ralph Henry Shaw, the poet and author of a biography of his father, published in 1893, and read before the Old Residents Historical Association of Lowell; Jennie May Shaw, who married Stanley James, of Concord, N. H., and Mary Alice Shaw (deceased). Benjamin Franklin Shaw died at his home in Lowell, Mass., December 11, 1890.

FRANK PERRY SHELDON.

Frank Perry Sheldon was born in Providence, Rhode Island, Feb. 16, 1848. He was the son of Jeremiah Angell and Mary (Burbank) Sheldon; grandson of Charles and Amy (Winsor) Sheldon, who was a direct descendant of Samuel Winsor, who married Mercy Williams, sister of Roger Williams, from which union began the Winsor family in Rhode Island.

The subject of this sketch was educated in public schools in his native town, and after graduation from the high school took a special course in the scientific engineering and mechanical department of Schofield's Commercial College, Providence, Rhode Island. He then went into the office of N. B. Shubarth, civil engineer, where he remained for about a year. He was subsequently employed by the American Screw Co. in mechanical drawing, and from that establishment passed into the machine shops of James Brown, Pawtucket, R. I. Mr. Brown recommended him to Mr. Foster Stafford, treasurer of the Union Mills, Fall River, who accepted his services, this being his first position in connection with a textile manufactory, and here he made the plans of the No. 2 Mill in 1867. He acquired large practical mill experience under Edward Kilburn, of Lonsdale, R. I., and in 1869 we find him making plans of the Wamsutta Mill, No. 4, New Bedford, when the Wamsutta was under the management of Thomas Bennett. Here he was occupied over a year.

At about this time, Mr. Sheldon designed the first automatic machine screw-threading machine for the American Screw Company, which was patented and adopted for general use in their mills, effecting a very large saving in labor. Mr. Sheldon also secured an English patent on the machine and sold it to an English Screw Company.

In 1870 Mr. Sheldon established himself in business in Providence as

a mill engineer. In 1903, his son, Arthur Noyes Sheldon, was admitted to partnership, and in 1907 Frank Lawrence Sheldon, his second son, was admitted to the firm, the style being F. P. Sheldon & Sons. From 1870 Mr. Sheldon gave his entire time to the business of mill engineering, including steam, hydraulic, electrical, and general industrial engineering, and installed and reorganized several hundreds of the most prominent textile establishments in the country, among which were such well-known concerns as the Wamsutta Mills, Pierce Manufacturing Corporation, Berkshire Cotton Manufacturing Company, Grinnell Manufacturing Corporation, Dartmouth Manufacturing Corporation, Draper Company, Pacific Mills, Arnold Print Works, Lonsdale Company, Ponemah Mills, Lorraine Manufacturing Co., Grosvernor-Dale Company, Manville Company, West Boylston Mfg. Co., Baltic Mills, Potomska Mills, Brookside Mills, Erwin Cotton Mills, Otis Company, Acushnet, Hathaway, Warwick Mills, Page Mfg. Co., Joseph Benn & Sons, Lawton Spinning Co., besides many plants in other lines of industry, including Gorham's Silver Works, and a large number of Electric Power Stations. He was also frequently called upon to make reports on industrial plants for reorganization and valuation.

In 1900 Mr. Sheldon was appointed director of textiles to the United States Commission of the Paris Exposition, being selected to that position by W. B. Plunkett (a personal friend of President McKinley) an appointment which was unqualifiedly endorsed by Senators Aldrich and Wetmore, Governor Dyer, of Rhode Island, William H. Bent, president of the Arkwright Club, of Boston, S. N. D. North, treasurer of the National Woolen Manufacturers' Association, General William F. Draper, and the heads of several of the leading textile manufactories in New England. Mr. Sheldon was also a member of the American Society of Mechanical Engineers, and of the National Cotton Manufacturers' Association.

In 1877, Mr. Sheldon married Nellie Noyes, by whom he had three children: Arthur Noyes, Bertha Louise and Frank Lawrence. Mrs. Sheldon died in 1883. Mr. Sheldon married (second) in 1892, Mary Elizabeth, daughter of Sumner White and Mary (Leonard) Lincoln, of Norton, Mass.

HOWARD STOCKTON.

Howard Stockton was born in Philadelphia, Pa., Feb. 15, 1842; son and only child of Philip Augustus and Mary Ann (Remington) Stockton; grandson of Lucius Whitman and Eliza Augusta (Coxe) Stockton; great-grandson of Judge John and Abigail (Phillips) Stockton; great-grandson of Richard and Susanna (Robinson) Stockton and great-third-grandson of Richard and Abigail Stockton who came from England to America and

was a freeholder in Flushing, Long Island, N. Y., about the year 1656, and with his son, Richard, removed to Burlington County, N. J., Richard, Jr., becoming a resident of Stony Brook (near Princeton), N. J. Philip Augustus Stockton was a lieutenant in the U. S. Army and consul-general to Saxony.

The subject of this sketch, Howard Stockton, attended a private school in Newport, R. I., and the Royal Saxon Polytechnic, Dresden, Saxony, from which he was graduated silver medallist in 1862. On returning to the United States, he entered the volunteer service June 9, 1862, as aide-de-camp with the rank of captain. On March 17, 1864, he was made first lieutenant in the Third Rhode Island Cavalry and May 23, 1864, second lieutenant in the Ordnance Corps U. S. A. and was brevetted first lieutenant and captain U. S. A. September 14, 1866. He was promoted to the rank of first lieutenant, Ordnance Corps, U. S. A. May 13, 1867. He resigned from the army January, 1871, and was admitted to the bar September 20, 1871, opening practice in Boston.

Howard Stockton was largely interested in the manufacture of cotton and was treasurer of the Cocheco Manufacturing Co., Dover, N. H., 1876-87; treasurer of the Salmon Falls Manufacturing Company, Salmon Falls, N. H., 1880-87.; treasurer of the Merrimack Manufacturing Company, Lowell, Mass., 1889-1900, and treasurer of the Essex Company controlling the water power at Lawrence, Mass., 1882. He was president of the Nashua Manufacturing Company, Nashua, N. H., from 1897 to 1909; president of the Jackson Co., Nashua, N. H., from 1897 to 1909; president of the American Bell Telephone Company 1887-89; actuary of the Massachusetts Hospital Life Insurance Company 1901; director of the Merchants' and old Boston National Bank; of the City Trust Company and of the Boston Manufacturers' Mutual Insurance Company; vice-president and director of the Old Colony R. R. Co.; vice-president of the American Mutual Liability Insurance Company; vice-president of the Boston Athenæum, trustee of several large estates and a member of the executive committee of the Corporation of the Massachusetts Institute of Technology. He was for many years a vestryman of St. Paul's Church, Boston; a member of the Standing Committee of the Diocese of Massachusetts 1890, and delegate to the Diocesan Convention from 1888 to 1892.

Mr. Stockton married, at Boston, Mass., Jan. 6, 1870, Mary, daughter of Rev. S. Charles Mason and Susan, daughter of Amos Lawrence, granddaughter of Jeremiah and Mary (Means) Mason, and of Amos and Sarah (Richard) Lawrence and a descendant in the eighth generation from John Mason, the hero of the Pequot War, 1637, and of John Lawrence, of Watertown, Massachusetts Bay Colony, 1630. Their children were: Lawrence Mason Stockton, born in Springfield, Mass.. Feb. 18, 1871; Harvard 1891, Harvard Law School 1894, law firm Stimson & Stockton; director N. E. Trust Co., clerk Essex Company, Boston; City Councilman 1888-89,

court tennis champion of the United States. Mary Remington, born at Brookline, Mass., May 10, 1872, married, October 4, 1903, William Amory (second); Philip Stockton, born at Brookline, Mass., March 20, 1874 (q. v.); Ethel born at Beverly, Mass., September 2, 1876; Eleanor born at Milton, Mass., Aug. 25, 1878; Jane Mason, born at Boston, Mass., Nov. 27, 1880; Howard, Jr., born at Boston, Mass., Dec. 18, 1883, Harvard 1905. Mrs. Stockton died at Wareham, Mass., July 27, 1886.

CHARLES T. MAIN.

Charles Thomas Main was born in Marblehead, Mass., Feb. 16, 1856, son of Thomas, Jr., and Cordelia (Reed) Main; grandson of Thomas and Deborah (Phillips) Main, and of Lemuel Fish and Eunice (Holmes) Reed, and a descendant of Rev. George Phillips, who with his wife and two children left Boxted, Essex, England, April 12, 1630, and embarking on the "Arabella," reached Salem, Massachusetts Bay Colony, the June 12th following, and became the first minister of Watertown. Through his grandmother, Deborah (Phillips) Main, the subject of this sketch was connected with that family of which Wendell Phillips (1811-1884) was a member.

Thomas Main, Jr., was a machinist and engineer in Marblehead, where Charles Thomas attended the public schools and under a private tutor was prepared for matriculation at the Massachusetts Institute of Technology, where he was graduated S. B. 1876. He remained at the Technology Institute as an assistant instructor for three years, 1876-79, and then became draughtsman for the Manchester Mills, Manchester, N. H., in 1879; engineer for the Lower Pacific Mills, Lawrence, Mass., 1880-85, having charge of the reorganization of the plant; assistant superintendent, 1885; and superintendent, 1886-91. After 1891 he engaged in general engineering work, his present (1911) office being at 201 Devonshire Street, Boston.

Mr. Main's professional reputation secured for him membership in the American Society of Mechanical Engineers, American Society of Civil Engineers, the National Cotton Manufacturers' Association and in the Boston Society of Civil Engineers. While residing in Lawrence, he served as alderman of the city 1888-89-90, and a member of the school committee and trustee of the public library, 1891, and in Winchester served as a member of the Water Board from 1895 to 1906. In 1905 he was elected a term member of the corporation of the Massachusetts Institute of Technology.

Mr. Main was a member of the Exchange and Technology Clubs of Boston, and the Calumet Club of Winchester. His published papers read

Chas T. Main

before the scientific societies, of which he was either a regular or honorary member, covered the subjects: "Steam Power," "Water Power," "Mill Construction," "Valuation of Industrial Properties," etc.

As consulting engineer for many textile corporations he built some of the largest textile mills in the country, and many important steam and water power plants. He invented a receiver pressure regulator for compound engines which was widely used and he was consulted by many cities and States in regard to problems arising from public works.

Nov. 14, 1883, Mr. Main married Elizabeth, daughter of John and Mary (Freeto) Appleton.

OTIS PETTEE.

Otis Pettee was born in Foxboro, Mass., son of Simon Pettee, a blacksmith and man of considerable inventive powers, who manufactured implements of warfare for the army during the War of 1812, and while this work was going on Otis, then sixteen years old, rendered valuable assistance in his father's shop. He had at this time gained a good knowledge of arithmetic at the public school, and he began to make a special study of textile machinery, as cotton manufacturing was coming largely into vogue in New England. He worked in cotton factories in order to gain additional knowledge of the machinery, and he also established a small thread factory at Foxboro. When the Elliot Manufacturing Co. decided to equip their new cotton mills at Newton Upper Falls, Mass., in 1823, they secured the services of Mr. Pettee as superintendent of the construction and equipment of the mill, and early in 1824 he had Mill No. 1 in running order, having been obliged to inaugurate a machine shop and manufacture a great portion of the machinery at the mill on account of the difficulty in transporting proper machinery from Providence, then the principal source of supply. His success as a machinist resulted in the Elliot Manufacturing Company being called upon to supply other mills with machinery, and in this way a regular machine works was founded and looms and spinning machinery furnished to neighboring mills, including the total equipment for the Jackson Cotton Mills at Nashua, New Hampshire, in 1831, for which accomplishment Mr. Pettee was highly commended, and the Jackson Company presented to him a service of silver inscribed with words of appreciation. At the close of the year 1831, Mr. Pettee resigned as superintendent of the Elliot Manufacturing Company and purchased from that corporation the equipment of their machine works. He erected his plant half a mile from the Elliot Cotton Mills, and on completing the building he announced his readiness to equip cotton factories with the latest

and best machines for spinning and weaving from the opener to the loom. By August, 1837, he had added to his plant a complete iron foundry, and was thus independent of other machine shops for supplies of castings, etc. In 1837 his principal workshop was a three-story building 365 feet long. He lost his plant by fire in 1839, saving only the contents of his foundry and pattern storehouse. Fire had destroyed property valued at $100,000, and his insurance was small. However, he rebuilt within a period of six weeks' time and had new and better machinery. His orders came from mills being equipped in all parts of the United States and in Mexico and California.

His sons, Otis and George Pettee, were instructed in the business and became practical machinists, and when Mr. Pettee died in 1853 the sons with Henry Billings succeeded to the business, which they carried on under the firm name of Otis Pettee & Co. Mr. Pettee was a temperance and anti-slavery advocate, and he was a foremost worker in benevolent and social reforms. He discouraged the use of tobacco in every form, was a free-soiler in political faith and was made by that party a delegate to the National Liberty Convention held in Buffalo, N. Y., Oct. 7, 1847. He died at his home in Newton Upper Falls, Mass., Feb. 12, 1853.

FRANCIS WINTHROP DEAN.

Francis Winthrop Dean, born in Taunton, Bristol County, Mass., May 24, 1852, was the son of Samuel Augustus and Charity Williams (Washburn) Dean, and grandson of Robert and Sarah S. L. (Padelford) Dean, and Cromwell and Elizabeth (Storm) Washburn. For more than two centuries, or since 1637, when Walter Dean emigrated from Taunton, England, to America and settled in Taunton, Mass., that town has been the home of the Dean family. Samuel A. Dean was a well-to-do farmer, and his son, therefore, had many educational advantages. Subsequent to his graduation from the Taunton High School, Francis W. Dean entered the Lawrence Scientific School, of Harvard University, and in 1873 received therefrom the degree of Bachelor of Science, *Magna Cum Laude*. In 1874, he became instructor, and in 1875 tutor in engineering in the Lawrence Scientific School, and was thus engaged until 1882.

In 1882 Mr. Dean entered the employ of Erasmus Darwin Leavitt, the eminent mechanical engineer, with whom he was associated until the fall of 1889, serving as special assistant, inspector, and chief draftsman. In 1889 he opened an office in Boston as mechanical engineer, and in 1893 Mr. Charles T. Main joined him, forming the firm of Dean & Main, Mill

F. W. Dean.

Engineers and Architects. On January 1, 1907, this firm was dissolved, after which time Mr. Dean followed the same business.

Mr. Dean was not a man of multifarious business interests, devoting almost his entire time and effort to his engineering practice. He was Sewer and Water Commissioner of Lexington, Mass., a member of the Exchange Club, Boston, the Harvard Union, Cambridge, the Harvard Club, New York, and the Engineers' Club, New York, also of the American Society of Mechanical Engineers, the Boston Society of Civil Engineers, the New England Water Works Association, and was for some time a member of the Institution of Mechanical Engineers, of England. Also a member of the National Association of Cotton Manufacturers.

March 8, 1893, Mr. Dean married Lydia C. H. Cushing and had two children, Samuel Winthrop, born August 29, 1897, and Francis Hale, born January 9, 1899.

WILLIAM MASON.

William Mason was born in Mystic, Conn., in 1808. His father was a blacksmith, who conducted also a small farm. William Mason attended the district school four months of each year, and the remaining eight months assisted his father in the shop and on the farm. He early evinced mechanical ability which he employed in constructing toys out of wood, jewsharps, skates, sleds and also musical instruments. When thirteen years old he was sent by his parents to work in a small cotton mill in Canterbury, Windham County, Conn.; he was employed in the spinning-room for about four years, and while there he constructed a "hurdy-gurdy," which he always retained as an example of his boyish genius. He then went to Lisbon, Conn., to work in a cotton-thread factory, and during the year he was there he was the only machinist in the place able to repair the complicated machinery used in the mill. He was then only seventeen years old, and his fame as a skilled workman and ingenious mechanic went before him to East Haddam, where a mill to spin thread was being put up, and he was sent for to start the machinery in motion. This experience induced him to learn the details of machine work, and for that purpose he returned to Canterbury, taking a three years' course as apprentice in the machine shop connected with the cotton mill. In 1826 he obtained work in a machine shop at New Hartford, N. Y., where he worked for a financially embarrassed concern for about six months, when he returned to Canterbury to his old employer, and his first mechanical achievement was finishing and setting up a power loom for weaving diaper linen, the first power loom used for that purpose in the United States. He also constructed a loom for weaving damask tablecloths, in which the figures of the middle

and borders were interwoven. His employer failed soon after and his loom was not continued in use. He then took up portrait painting in oil, but was soon back to the machine shop, as in 1832 he received an order from John Hyde, of Mystic, to construct diaper looms, and Mr. Hyde advanced him money on his contract to enable him to set up business on his own account in a frame maker's shop in Willimantic, Conn.

His successful completion of this contract led to an engagement with Ansell Lanphear, of Killingly, Conn., and in his machine shop Mr. Mason undertook the construction of the ring and traveller, or ring-frame, the invention of John Thorp, of Providence, R. I., patented Dec. 31, 1828, but up to this time no one had been found able to carry out the inventor's plans. Mr. Lanphear failed, and the youthful machinist took charge of the shop in the interest of the creditors, they agreeing to give him a percentage on the business. He improved on Thorp's ring-traveller, remodeled and perfected the "ring" and designed a new and light iron frame, which gave evidence of his ingenuity and skill. The successive failures of his predecessors prejudiced mill men against this invention, and the ring traveller that came into universal use after a time was at first unwelcomed. After working in Killingly for two years, he was induced in 1836 by Crocker & Richmond, of Taunton, Mass., cotton-machinery manufacturers, to transfer his ring-frame work to their establishment, and in the financial crisis of 1837, the failure of the firm—owing him a large amount—made another change in his business connections, and when Leach & Keith took possession of the old machine shop he was employed as foreman, and the firm made his newly-patented "speeder" or "roving machine" a specialty.

Meanwhile, in his intervals of leisure, Mr. Green had been industriously working on the "self-acting mule," which eventually proved to be the most important invention of his life. He received a patent for this machine Oct. 8, 1840. He encountered great opposition in the "Scotch mule," introduced in the United States about the same time, and the next year the "Roberts and Sharp mule," imported by Major Bradford Durfee, and patented in the United States, Oct. 11, 1841, proved a formidable rival. As this machine proved in some respects superior to the one invented by Mr. Mason, that persistent machinist, quite undaunted by these setbacks, set about making an entirely new model, which was completed in 1842, and for which he received a patent Oct. 3, 1846. This latest machine became known as Mason's self-acting mule."

About this time disaster again overtook him in a protracted illness and the failure of Leach & Keith, through which he lost a large amount. On recovering his health, he was enabled, through the financial help of James K. Mills & Co., cotton commission merchants, of Boston, to purchase the machine shop of Leach & Keith, and it was opened propitiously in 1842 under his sole management. During the summer of 1845 he completely remodeled the entire plant, removing it to a better

location, he erected new buildings, conveniently arranged and planned to eventually cover an area of ten acres, making it the largest and most complete cotton machinery works in the United States. His business, principally the manufacture of his self-acting mule, was so successful that when his new plant was finished he was half owner and out of debt. He added to the business of making cotton machinery that of machinery for the manufacture of woolen goods. He also produced printing-presses, machinists' tools, blowers, cupola-furnaces, gearing and shafting. In 1852 Mr. Mason devised the model for a new locomotive, and in 1853 produced a completed engine, differing in radical form from the English model introduced by Horatio Allen, of New York, and followed by Matthias W. Baldwin, of Philadelphia, and Thomas Rogers, of Paterson, N. J., pioneer engine builders in the United States, in 1830, 1832 and 1837 respectively. The Mason locomotive excelled in workmanship, taste and beauty of form all of its predecessors, and they gradually adopted his improvements. In 1852 he had erected additional buildings to accommodate this new industry in which he vigorously engaged. The failure of James K. Mills & Co., of Boston, his equal partners in the mill-machinery and locomotive works, compelled the machine works to suspend payments, and Mr. Mason was again compelled to start anew. This time he did it on his own account, and, after becoming solidly established, he equipped a foundry for the manufacture of car-wheels, which he made with hollow or tubular spokes to insure more strength and to conform with the driving wheels used on his locomotives. In 1861 he added to his plant an arsenal equipped with machinery, much of which he invented and made, for the manufacture of muskets for the United States army, and he soon began to turn out 600 Springfield rifled muskets a week. This gave him, during the progress of the Civil War, 1861-65, five branches of business, running at full capacity, cotton machinery, woolen machinery, locomotives, car-wheels and firearms, besides miscellaneous machine work. The return of peace closed the arsenal, and soon after the manufacture of woolen machinery was stopped. In 1873 the business was organized as the Mason Machine Works, for a history of which see article in this work under that title. Mr. Mason died in Taunton, Mass., May, 1883.

DWIGHT SEABURY.

Dwight Seabury, born in Providence, R. I., Feb. 14, 1863, was the son of Frederick Niles and Catharine Amelia (Wheaton) Seabury; grandson of Captain George Briggs and Patience (Thurston) Seabury, and a descendant of John Seabury, of Porloke, Devonshire, England, who came to and settled in Boston during 1630. Frederick Niles Seabury was a prominent dentist in Providence, R. I.; president of the American Academy of Dental Science of Boston, and member of the New York Odontological and New York State Dental Societies and American Dental Association, and his father was a mechanical engineer and a veteran of the War of 1812. The subject of this sketch received his elementary education at Mowry & Goff's School, Providence, which was followed by a course at the Providence High School and Schofield's Commercial College, of the same city. In 1881 he entered the mill engineering office of Thompson & Nagle and served an apprenticeship of three years, at the expiration of which term he went with Mr. David M. Thompson, as his assistant, to the employ of B. B. & R. Knight, Providence, R. I., assisting in the reorganization of the Natick Mills, Arctic Mills and Pontiac Mills. His next position was with Mr. Frank P. Sheldon, mill engineer, Providence, in whose employ he remained for nine years. In September, 1896, Mr. Seabury established himself in business in Pawtucket, R. I., and among the buildings that he designed and reorganized are included: five different mills of the Royal Weaving Company, Pawtucket, R. I.; the Brighton Mills, Passaic, N. J.; Solway Dyeing & Textile Co., Pawtucket; Tamarack Company, Pawtucket; Penikees Mills, Valley Falls, R. I.; Portland Silk Company, Middletown, Conn.; Lumb Knitting Company, Pawtucket; E. Jenckes Manufacturing Company, Pawtucket; Jenckes Spinning Company, Pawtucket; D. Goff & Sons, Pawtucket; Burlington Silk Mills, Burlington, N. J.; Fort Dummer Mills, Brattleboro, Vt.; Pawtucket Electric Co., Pawtucket; Waite-Thresher Company, Providence; Improved Seamless Wire Company, Providence; Geo. W. Parks Company's Building, Providence; A. T. Atherton Machine Company, Pawtucket; Nockage Mills, Fitchburg; Orswell Mills, Fitchburg, and the Ponikin Mills, Lancaster, Mass.; American Textile Company, Pawtucket; Union Wadding Company, Pawtucket; Matteawan Manufacturing Company, Matteawan, N. Y.; Reiling & Schoen, West Hoboken, N. J.

Mr. Seabury joined the National Association of Cotton Manufacturers in 1901, and the American Society of Mechanical Engineers in 1906, and became a member of the To Kalon Club during the same year.

February 14, 1898, Mr. Seabury married Hattie Idella, daughter of Horace Leonard and Emily Emeline (Gotha) Fisk.

Dwight Seabury

HERBERT EDWARD WALMSLEY.

Herbert Edward Walmsley was born in Manchester, England, in 1855. His father, Francis H. Walmsley, was a leading physician and publicist, and Herbert Edward Walmsley was provided with an excellent education, acquired at the best school in his native city; and, wishing to enter mercantile life, according to the custom of the place, was apprenticed at an early age to acquire the business of manufacturing cotton yarns and cloth. He thoroughly mastered the details of the mill, and when twenty-two years old accepted the management of a large cotton mill in Russia, remaining in that position for about eleven years. He then accepted a similar position in a mill in India, but in the climate of that warm country he found that his previous excellent health was being impaired, and he left India before completing his first year's service, and in 1887 came to the United States to accept the position of manager of the extensive Clark Thread Works at Newark, N. J. The reputation he gained there during ten years' service as a broad-minded and entirely competent mill manager, thoroughly informed in all the details and methods of manufacturing raw cotton into the various threads, yarns and fabrics to which it is adapted, and satisfactorily proving his great executive ability in conducting the affairs of the largest establishment, had attracted the attention of the cotton manufacturers of the United States. Mr. W. W. Crapo, president of the Wamsutta Mills, the pioneer cotton factory of New Bedford, Mass., one which had acquired a world-wide fame for the superior quality of its product, finding constant use for 230,000 spindles, 4,450 looms, 2,100 hands and a capital of $3,000,000 paying large dividends, saw in Mr. Walmsley the man he needed to meet the demands not only for the class of goods the seven mills were turning out, but to add to the establishment every improvement possible, so as to maintain that supremacy, and secured his services as agent in 1897. He was twice elected president of the New England Cotton Manufacturers' Association, and on various occasions he addressed that body upon the subjects of "Industrial Institutes—Their Organization and Regulations;" "Industrial Unity;" "Manufacture of Fine Yarns;" "Preparations for Mill Management;" "Relations of Employers and Employees in Cotton Mills;" "Rope Driving;" besides his annual inaugural and semi-annual addresses. In 1904 he was a member of the International Jury of Awards in the Department of Textiles at the Louisiana Purchase Exposition at St. Louis. He was also a member of the Board of Government of the New Bedford Textile School, having declined the presidency of the institution. His book on cotton spinning and weaving passed through several English editions, and was translated into the Russian language.

THEOPHILUS PARSONS.

Theophilus Parsons was born in Brookline, Mass., July 1, 1849; son of Thomas and Martha (Franklin) Parsons; grandson of Charles Chauncy and Judith Parsons and Henry Paine and Charlotte Bicknell Franklin; great-grandson of Judge Theophilus and Elizabeth (Greenleaf) Parsons.

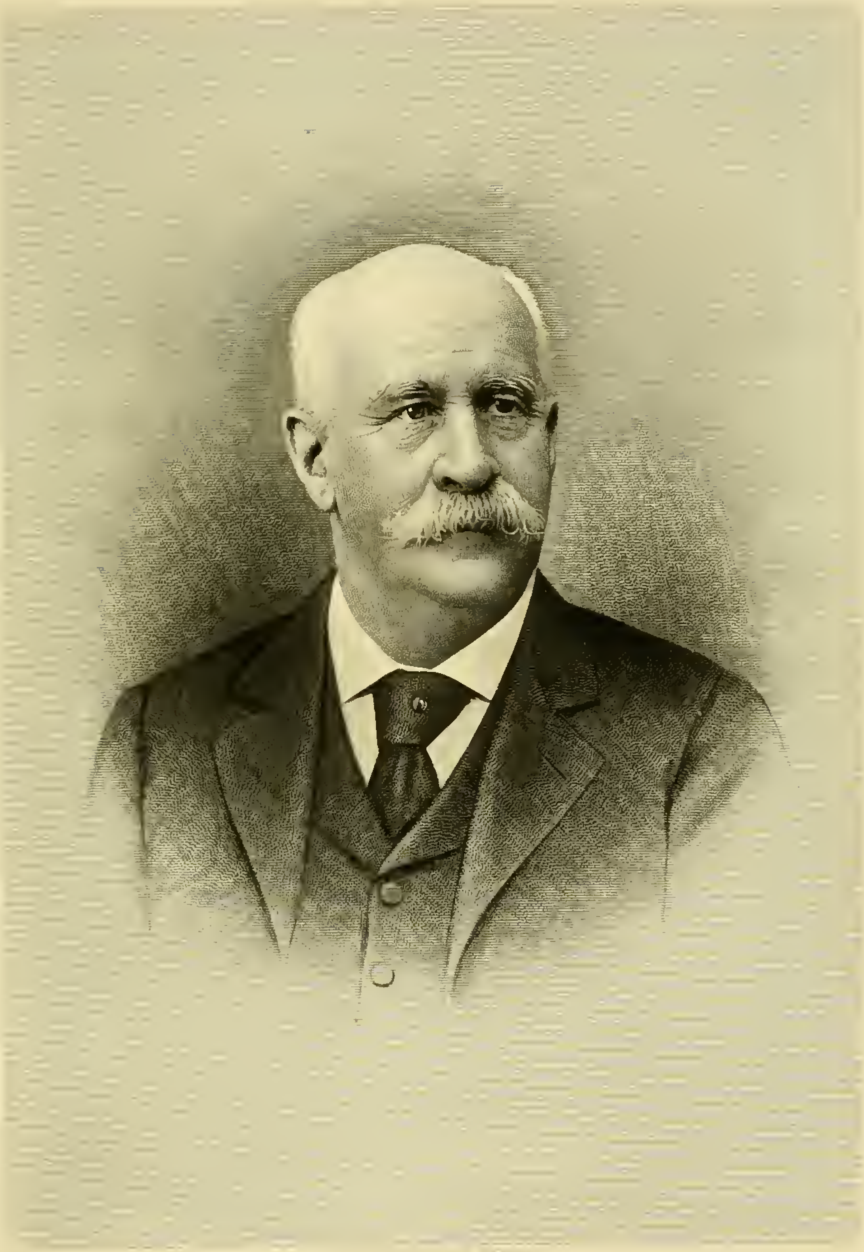
Theophilus Parsons was trained for college at preparatory schools in Brookline, including the Brookline High School; was graduated from Harvard, A. B., in 1870, and the following October began his career as a manufacturer of cotton in the Lyman Mills, Holyoke, Mass., where he was a student in the textile industry up to November, 1872, when he continued his studies in the large European manufactories. He was agent of the Pocasset Manufacturing Company, Fall River, Mass., from January 1, 1880, to September, 1880, when he accepted a similar position with the Lyman Mills, Holyoke, and on October 1, 1884, he was elected treasurer of that corporation, with his office in the Exchange Building, Boston. Mr. Parsons was elected president of the Arkwright Club in 1900, and in 1910 resigned that position, his successor being F. C. Dumane, treasurer of the Amoskeag Mfg. Co.

Mr. Parsons was married August 15, 1894, to Mary Mason, daughter of Dr. F. Oliver. They had one child, Susan Lawrence Parsons, born July 28, 1895. Mrs. Mary Mason (Oliver) Parsons died in Boston, Mass., October 25, 1895.

THEOPHILUS KING.

Theophilus King was born in Rochester, Plymouth County, Mass., Dec. 14, 1844; son of Theophilus and Mary (E.) King. His maternal Pilgrim ancestors, from whom he was of the eighth generation, were John Howland and Elizabeth Tillery, both passengers of the Mayflower, 1620, who were married in Plymouth Colony, the first marriage ceremony performed by the Pilgrims on American soil. John Howland was the last survivor, living in Plymouth, of the historic band that founded the colony in 1620.

Theophilus King attended the public school and academy at Rochester, and his first experience in business was gained on his father's farm and in his store in Rochester. He also had experience as post-office clerk, insurance clerk and assistant town-clerk, as well as assisting in looking after a saw mill, in all of which enterprises his father was the head. He began to trade in furs and to raise potatoes on his own account when thirteen years old, and when he was fifteen he owned a sixty-fourth part of the whaler "Admiral Blake," paid for out of his own earnings. He sold his



Theop. Parsons.

Theophilus King

interest in the whaler for a fair profit, after holding it over one year, and in 1860 he went to Boston, where he had neither friends nor influence and found employment in the leather store of Johnson & Thompson as clerk, remaining with the firm until he was twenty-four years old and until he had gained a practical knowledge of the leather business. He then formed a partnership with Charles B. Bryant, and the leather firm of Bryant & King prospered up to the time of the great fire of 1872, when they lost their property in Boston by fire. Later their factories at Clinton, Mass., were destroyed by flood, in 1876, and the firm suspended, paying their creditors seventy cents on the dollar. Six years later the firm voluntarily paid every creditor the entire balance of their claims with interest at six per cent. The disaster did not deter the firm, and they continued the business up to 1887, when it was transferred to a company. Mr. King engaged in new business ventures and in diversified manufacturing interests, in which he was eminently successful as a director, trustee, assignee, receiver and banker, and soon gained a prominent position in both the manufacturing and financial world. His interest in the cotton manufacturing business included an activity which was most largely influential in creating the Colored Cotton Mill Co., Limited, of Canada, embracing the seven principal colored cotton mills of the Dominion in which he was a director. He also became president and a director of the Dallas Cotton Mills, Dallas, Texas; and treasurer of the Summit Thread Company, of Boston, and East Hampton, Conn.; the president of the Lawrence Duck Company, Lawrence, Mass.; treasurer and director of the Abington Mills (cotton), Huntsville, Ala., and of the cotton commission concern of Wm. L. Barrall Co. He was also vice-president of the National Bank of Redemption for many years, president of the Tidewater Coal and Coke Company, and of the Quincy Quarries Company; incorporator and treasurer of the Riverside Worsted Mills, the Atlantic Mills, of Providence, R. I., and the Eureka Silk Manufacturing Company, of which he became president. These three corporations represented an aggregate capital of $3,126,-000, employed 4,500 persons, and did an annual business of over $7,000,000.

Mr. King was an advocate of outdoor life, a zealous and expert baseball player in his youth, and, later in life, equally expert at golf. He was an active worker in church and temperance work, a member of the Reform Club, of New York City, and in the Cachato Club, of Braintree, Mass., Boston City Club, and of golf and other athletic clubs and associations.

Mr. King married, Dec. 31, 1873, Helen L., daughter of James and Mary Ann Baxter, of Quincy, Mass., and their children were Delcevare and Zayma King.

ARTHUR HOUGHTON LOWE.

Arthur Houghton Lowe was born in Rindge, Cheshire County, New Hampshire, August 20, 1853. He was one of the seventeen children of John and Sarah (Mead) Lowe, grandson of David Lowe and a descendant of Thomas Lowe, who came from England about the year 1630 and settled in Ipswich, Massachusetts Bay Colony. Arthur Houghton Lowe spent his early life in Fitchburg, Worcester County, Mass., where he attended the public schools. When quite young, he left school to join in the provision and produce business conducted by his father and older brothers, and on reaching his majority he became a partner in the firm of Lowe Brothers & Company.

In 1879, with John Parkhill and Thomas R. B. Dole, Mr. Lowe formed the Parkhill Manufacturing Company, for the manufacture of fine ginghams. He managed the business of the little mill, which, at its inception, had only thirty looms, but which grew to be one of the largest of its kind in the country. Of this corporation he was elected treasurer and manager. In 1885 he organized the Cleghorn Mills Company, which enterprise contributed greatly to the building up of the Daniels District of the City of Fitchburg, for within six years this section contained two hundred houses, a church, schoolhouse and five large factories, including the Orswell and the Mitchell Mills, which came into existence and grew rapidly through his personal efforts and enterprise. The Cleghorn Mills were absorbed by the Parkhill Manufacturing Company in 1889.

Mr. Lowe also organized and became treasurer of the Lowe Manufacturing Company, of Huntsville, Ala., and was a partner in the commission firm of J. Harper Poor & Co., of New York City. He likewise was a director of the Fitchburg National Bank, the Fitchburg Mutual Fire Insurance Company, Mutual Insurance Companies of Boston, the Street Railway Company, the Fitchburg Steam Engine Company, and of the Grant Yarn Company, and was trustee of the Fitchburg Savings Bank, Cushing Academy, State Trustee of Baldwinsville Hospital for Children and trustee of the Murdock School at Winchendon. He served as director of the Park Club, and was also a member of the Fitchburg Athletic Club.

Mr. Lowe was an alderman of the city of Fitchburg in 1888, president of the Board of Trade in 1891 and 1892, and mayor in 1893, and served the Commonwealth of Massachusetts as a member of the Governor's Council in 1903 and 1904. He was largely responsible for the location of the extensive car shops of the Fitchburg Railway Company in the southern part of the city in 1888, at a time when several other cities on the route were working strenuously to secure the advantages the plant afforded to the place in which it should be located.

Mr. Lowe married, Dec. 11, 1878, Miss Annie E. Parkhill, and had three children—Russell B., Margaret, and Rachael P. Lowe.

Arthur H. Lowe

WILLIAM H. JENNINGS.

William H. Jennings was born in Fall River, Mass., Feb. 20, 1831; son of Edward and Betsey (Palmer) Jennings, and a descendant of John Jennings, who came to America from England in 1720. William H. Jennings was educated at the public schools of Fall River and at a private school; and when thirteen years old he entered the grocery store of C. H. Greene, and later was with Gray & Brownell, and R. S. Gibbs & Co. He went from the mercantile business into that of railroading, and adjusted land and other damages existing between the Old Colony Railroad and owners of property through which the railroad passed in the process of its extension to Newport, R. I.

In 1866 Mr. Jennings organized the Merchants' Manufacturing Company, became treasurer and clerk of the corporation, and raised the money that placed its capital stock at $800,000 in the short space of two days; and a charter was obtained Nov. 2, 1866, with James Henry, W. H. Jennings, Augustus Chace, L. L. Barnard, Richard S. Gibbs, Charles H. Dean, Crawford E. Lindsey, Robert Remington and Lafayette Nichols as directors, James Henry being elected the first president of the corporation. Mr. Jennings remained with the company as treasurer and agent and carried on the business successfully from the completion of the largest cotton mill building under one roof in Fall River, its equipment with the best machinery then obtainable, and the production of a superior quality of print cloths, which found a ready and profitable market; resigning his position in 1882, after eighteen years devoted almost exclusively to its manifold interests.

With Stephen Davol, John D. Flint, Lloyd S. Earle, Walter C. Durfee and Dr. Robert T. Davis he arranged for the incorporation of the Wampanoag Cotton Mills and invited subscriptions to its stock, and between May 23, 1871, the time of the organization, and May 31 following, $400,000 had been subscribed, and he served the corporation as a director up to the time of his death. He was one of the founders and charter directors of the Flint Mills, organized in February, 1872, with a capital of $500,000, and was also a member of its board of directors. Oct. 14, 1873, his efforts greatly aided those of Louis L. Barnard, Stephen Davol and Nathaniel Borden in organizing the Barnard Manufacturing Company with a capital of $330,000, and he was a member of its first board of directors and served as the second president of the corporation, 1880-85.

His next effort in the direction of cotton mill promotion was in April, 1881, when, in co-operation with Dr. Robert T. Davis, Frank S. Stevens, Arnold B. Sanford and others, he caused the incorporation of the Globe Yarn Mills, April 16, 1881, and was prevailed upon to accept the presidency of the corporation, which, starting with a capital of $175,000, under his inspiration the capital was increased to $200,000; in October, 1881, to

$356,000, and in 1885 to $600,000, in order to build Mill No. 2. Mr. Jennings was also a large stockholder and president of the Globe Street Railway Company, a director of the Crystal Spring Bleaching & Dyeing Company, the Manufacturers' Mutual Fire Insurance Company and the Metacomet National Bank. His real estate holdings, in co-operation with Dr. Robert T. Davis and Frank S. Stevens, included a large tract of land west of Broadway, Fall River, on which the Globe Yarn Mills, the Laurel Lake and Sanford Spinning Mills and the Algonquin Printing Company's plants were erected.

Mr. Jennings was a Republican member of the Common Council, 1856, 1858 and 1859, and president of that body in 1859. He was affiliated with the Central Congregational Church, of Fall River, and a member of the building committee which erected its new edifice in 1874.

Mr. Jennings married, Dec. 24, 1863, Annie Borden Chase, of Portsmouth, R. I. They had four children, of whom Charles J. died March 31, 1877; Edward B. Jennings became president of the Algonquin Printing Company 1890-96, treasurer of the Globe Yarn Mills from October, 1896, treasurer of the Samoset Company of Valley Falls, R. I., agent of the Allen Print Works of Providence, R. I., president of the Merchants' Manufacturing Company as successor of James M. Osborn, and a director of all these corporations, and of the Wampanoag Mills, the Sanford Spinning Company and the Stevens Manufacturing Company; William H. Jennings, Jr., treasurer of the Webster Loom Harness Co. and treasurer of the Algonquin Printing Company; and Annie J., married Arthur Anthony.

William H. Jennings died at his home, Fall River, Mass., in 1885.

WALTER EDWARD PARKER.

Walter Edward Parker was born in Princeton, Worcester County, Mass., Sept. 27, 1847; son of George and Emily R. (Coller) Parker; grandson of Ebenezer Parker, a farmer of Princeton, and of Hezekiah Coller, a Methodist preacher of Northfield, Mass., and a descendant of Thomas Parker, a farmer who embarked at London, England, March 11, 1635, with Sir Richard Saltonstall, with whose family he was connected by marriage. Captain John Parker, who led a company of farmers in the Battle of Lexington, 1775, and Theodore Parker, the eminent preacher, were of this family. George Parker was a farmer and manufacturer of textile goods, and his son, Walter Edward Parker, was brought up in Princeton, Mass.; Urbana, Ill., and Woonsocket, R. I. He attended the public schools, became a clerk in a grocery store in Woonsocket, R. I., and in the Social Cotton Mill. He subsequently in 1876 accepted the super-

W. E. Parker

intendency of the Globe Mills, owned by the Social Manufacturing Co., and served until April 1, 1881, when he became superintendent of the cotton department of the Pacific Mills at Lawrence, Mass. This position was relinquished by Mr. Parker in 1887 for a higher office with the same concern, that of agent of all the mills and print works controlled by them.

Mr. Parker was an energetic and interested worker, and held offices in many institutions, being elected trustee of the Lowell Textile School upon its organization. He also was made a trustee of Tufts College and chairman of the finance committee; trustee of the Essex Savings Bank, Lawrence; trustee of the "White Fund," Lawrence, and trustee of the Lawrence Public Library. He served as chairman of the advisory board of the Lawrence General Hospital, and also of the Board of License Commissioners of Lawrence, by appointment of Mayor Rutter. He likewise served as president of the Lawrence City Mission, of the Essex Savings Bank and of the Lawrence Lumber Company, and became a director of the Merchants' National Bank, Lawrence, and of the City Manufacturing Company, of New Bedford, Mass. He was made a life member of the Royal Society for the Encouragement of Arts, Manufactures and Commerce, London, England; of the American Society of Mechanical Engineers, of the National Association of Cotton Manufacturers, serving as president of the association, 1889-92, and of the Geographical Society of Washington, D. C. He was admitted a member of the Boston Society of Civil Engineers and of the Society of Arts, Massachusetts Institute of Technology, and became a founder and second president of the Textile Club. He was elected alternate delegate to the Chicago Convention that nominated Theodore Roosevelt in 1904, and delegate to the Republican Convention four years later when William H. Taft was nominated for president. June 14, 1902, the degree of M. A. was conferred upon him by Tufts College.

In 1877 Mr. Parker married (first) Alida C., daughter of Rev. John Howard Willis, and had one child, Helen Parker Hamilton. Jan. 1, 1888, he married (second) Mary Bradley Beetle.

OLIVER H. MOULTON.

Oliver H. Moulton was born at Dover, N. H., Oct. 31, 1829, and was the son of Thomas T. and Sarah (Pike) Moulton, the latter being a daughter of Senator Benjamin Pike, of Maine.

Mr. Moulton, the subject of this sketch, spent his early life in Saco, Maine, where he was educated in the public schools and at Saco Academy. Completing his education, his first position was that of an apprentice to

the machinist trade, and as such he worked in Saco for six years. He then went to the York Cotton Mills to learn the business. He also was one of the founders of the Pepperell Mills at Biddeford, Maine, where he was associated with Mr. Stephen Everett.

In 1854 Mr. Moulton went to Lawrence, Mass., and entered the employ of the Pemberton Mills, for which concern he acted as overseer during a period of five years. He then became superintendent of the Amoskeag Mill at Manchester, N. H., under Governor Straw. His next change was made in May, 1864, when he went to Lowell and accepted the position of superintendent and general manager of the Hamilton Manufacturing Company. From his early manhood Mr. Moulton was connected with cotton manufacturing industries. In addition to his other interests, he was a director of the Kitson Machine Company, Shaw Stocking Company, Lowell and Andover Railroad Company, president of the Lowell Hospital Association and Lowell Central Savings Bank, and was a member of the New England Club of Boston and The Club of Lowell.

In 1856 Mr. Moulton married Miranda O., daughter of Tristram Jordan, a citizen of prominence at Saco, Maine. Mrs. Moulton died Jan. 31, 1895, her husband and two out of the three children born of this union surviving her. One of the children, May Leonard, married Mr. Austin K. Chadwick, treasurer of the Lowell Five Cents Savings Bank; while the other, Alice Maud, became Mrs. Henry Bartlett, her husband being superintendent of the motive power of the Boston and Maine Railroad Company.

WILLIAM HENRY HILL.

William Henry Hill was born in Boston, Mass., July 14, 1838. He was the son of William Henry and Abbie F. (Remich) Hill; grandson of James and Abigail (Hill) Hill, and a descendant through Captain James and Eunice (Gruard) Hill, Captain Elisha and Mary (Plaisted) Hill, Captain John and Mary (Frost) Hill, Roger and Mary (Cross) Hill, from Peter Hill, the immigrant ancestor who was born in England, came to this country in 1632 and settled on Richmond Island, near Cape Elizabeth, Maine, and in 1644 leased land at Winter Harbour (subsequently Biddeford Pool), and in 1648 was a member of the General Court of Ligonia. Roger Hill became a resident of Saco, Maine, in 1653, and died there in 1667, and his son, Captain John Hill, commanded the fort erected at Saco for the defence of the place during the King Philip War.

Captain James Hill was one of the twelve citizens elected to receive General George Washington when he visited Portsmouth, 1789, he having been a soldier in the American Revolution. He was one of the party who

William H. Hill

went to Fort William and Mary at Portsmouth (now New Castle) on the night of Dec. 14, 1774, and captured one hundred barrels of gunpowder and carried it to Durham, N. H., from which place seventeen barrels were carted by ox team to Charlestown, arriving so as to be distributed to Putnam's army the day before the Battle of Bunker Hill. He also commanded a company in one of the four regiments of minute men raised by order of the Fourth Provincial Congress, Sept. 1, 1775, for four months' service to be stationed at Portsmouth, New Castle, Kittery and vicinity to defend the coast seaward, and Captain Hill's company was ordered to Pierce's Island, Nov. 5, 1775. He also appears as ensign on the pay-roll of a company of volunteers commanded by Colonel John Langdon, which was with General Gates at Saratoga. His son, James, married Abigail Hill, a descendant of the Connecticut branch of the Hill family. Of William Henry Hill, of Boston, son of James Hill, we learn from "Names and Sketches of the Richest Men in Massachusetts" that he was a native of Portsmouth, Me. As a young man he came to Boston, where he was later identified with many of the prominent business interests of Boston. He was a pioneer and a director of the First National Bank of Boston, a director of the Boston Wharf Co. and of the Boston and Marine Insurance Co., president of the Boston & Bangor Steamboat Co., and held many other offices of trust and honor. He died in 1888.

William Henry Hill, the subject of this sketch, was graduated from the Roxbury High School in 1855; began his business career as a clerk, from 1855 to 1859, in the publishing house of Sanborn, Carter & Bazin and their successors, Brown, Taggard & Chase; became a partner in the firm under the style of Chase, Nichols & Hill, 1859-1861; was a bookseller and publisher on his own account from 1861 to 1869, and from 1869 to 1902 was an active member of the banking house of Richardson, Hill & Company.

Aside from his banking interests Mr. Hill has had many outlets for his energy and executive ability. In 1875, with his father, he came into control of the Boston and Bangor Steamship Company, at a time when its stock had a market value of one-quarter of its face value, and for twenty-five years thereafter, as managing director, treasurer and president, he directed the affairs of the company and placed its business on a solid foundation, put its stock far above par, built wharves and storehouses, added steamers of the best modern type to its fleet, and gained a vast freight and passenger traffic.

For a number of years Mr. Hill was president of the Assabet Manufacturing Company of Maynard; he was also president of the Windsor Company, of North Adams; of the Citizens' Gas Company, of Quincy; of the Renfrew Manufacturing Company, of Adams; of the Foster's Wharf Company, of Boston; a director of the First National Bank, of Boston; the International Trust Company; of the Boston Insurance Com-

pany; of the Eastern Steamship Company, a director of many other companies. Mr. Hill also acted as trustee of several estates, a member of the Boston Chamber of Commerce, the Boston Stock Exchange, the Boston Real Estate Exchange, the Bostonian Society, the Bunker Hill Monument Association, the Algonquin Club, the Boston Art Club, the Boston Athletic Association, the Boston Curling Club and the Country Club.

Mr. Hill married (first), Jan. 8, 1863, Sarah E., daughter of William B. May, of Boston. She was born Aug. 5, 1843; died July 6, 1904. Mr. Hill married (second) April 26, 1906, Caroline Wright Rogers, daughter of Charles E. and Mary J. (Williams) Rogers, a descendant of Thomas Rogers, a passenger on the Mayflower, and of Robert Williams, the ancestor of the Roxbury Williams family.

The children of William Henry and Sarah E. (May) Hill were Warren May Hill, born Oct. 28, 1863; married, Oct. 7, 1891, Mary E. Carney; Harold St. James Hill, born Nov. 9, 1865, died Aug. 10, 1866; Marion Hill, born Feb. 18, 1868; Clarence Harvey Hill, born March 12, 1870; Spencer Richardson Hill, born Dec. 6, 1871; married, June 7, 1899, Elizabeth Hale; Ernest Lawrence Hill, born Oct. 5, 1873; married, May 23, 1902, Annette Shaw; died Nov. 2, 1905; William Henry Reginald Hill, born Sept. 21, 1875; married, Oct. 25, 1898, Grace Whittier Thayer; Donald Mackay Hill, born Nov. 11, 1877; married, June 11, 1902, Annie Neal Turner; Barbara Hill, born Sept. 19, 1879; died Sept. 9, 1880; Philip Sanford Hill, born Aug. 16, 1881; died Aug. 2, 1885; Kenneth Amory Hill, born June 22, 1884.

WILLIAM HENRY BENT.

William Henry Bent was born in Cambridge, Mass., Jan. 2, 1839; son of the Rev. Nathaniel Tucker and Catherine Eliza Donnison (Metcalf) Bent; grandson of Josiah and Susanna (Tucker) Bent and of Eliab Wight and Lydia (Stedman) Metcalf, and a descendant from John Bent, who came from England to Massachusetts Bay Colony in 1638 and was an early settler of Sudbury. His first maternal ancestor in America was Michael Metcalf, born in Tatterford, England; came to Massachusetts Bay Colony in 1637 and settled in Dedham. Nathaniel Tucker Bent was a clergyman of the Protestant Episcopal Church, and was connected with the diocese of Massachusetts, and his son, William Henry Bent, spent his school days chiefly in Taunton and Worcester, where he attended the public schools and took a special course of instruction in civil engineering. His father, who in 1833 founded Grace Church, New Bedford, died in Worcester, Mass., in November, 1856, and this event decided the son to engage in business. He therefore entered the machinery-building establishment of

William Mason, in Taunton. The panic of 1857 caused the business to suspend for a time, and young Bent found work in Boston for a period of about twenty months, when he returned to the Mason Machine Works and remained with the concern, holding the office of treasurer from May 25, 1873. He was a director of the Machinists' National Bank of Taunton; of the Corr Manufacturing Company, at East Taunton, from 1895, and of the Nemasket Mills from 1891, the latter both extensive cotton mills. He served the city of Taunton as alderman for two years and as chairman of the Commissioners of Sinking Funds for twenty years. He also served as vice-president of the Morton Hospital, Taunton, from its organization in 1887.

Mr. Bent belonged to the Republican party, and he was a delegate to the Republican National Convention of 1888. He was a member of the Union Club of Boston (1873), the Arkwright Club of Boston, of which he was president for three years, and of the Home Market Club of Boston, of which he was president for three years.

He married (first), June 14, 1865, Harriett Fellowes, daughter of Charles J. and Adeline (Davis) Hendee; she died Feb. 21, 1873, and he was married (second), Jan. 29, 1885, to Sarah Elizabeth, daughter of Lewis Reese and Sarah Dawes (Shepard) Chesborough, of Elizabeth, N. J. By his first wife he had three children. Arthur Cleveland Bent, who was born Nov. 25, 1866, became general manager of the Mason Machine Works, of which his father was treasurer, and a member of the Board of Aldermen in 1906. Frederick Hendee Bent, born Feb. 16, 1869, died Jan. 14, 1897, and Charles Bent, born Feb 13, 1873, died in infancy.

HENRY G. KITTREDGE.

Henry G. Kittredge was born in Claremont, N. H., Jan. 22, 1841. His parents were Caroline A. (Smith) and Thomas Bond Kittredge, a celebrated physician and surgeon. His great-grandfather, Francis Kittredge, was a surgeon in the Revolutionary War. He was a lineal descendant of the Adams, Seymours, Spencers, Treats and Bonds, and a nephew of Dr. Ashbel Smith, of Texas, and Judge Henry G. Smith, of the Supreme Court of Tennessee. His home was with his parents in Keene, N. H., until early manhood, when he went to his grandparents in Hartford, Conn., where he finished his education.

Mr. Kittredge began his business career in a woolen mill, located at Biddeford, Me., and at the early age of twenty-one years he became superintendent of a fancy cassimere manufactory in Massachusetts, and was later appointed agent of a Maine corporation. He subsequently purchased a mill in Massachusetts, and started a wool and cotton business.

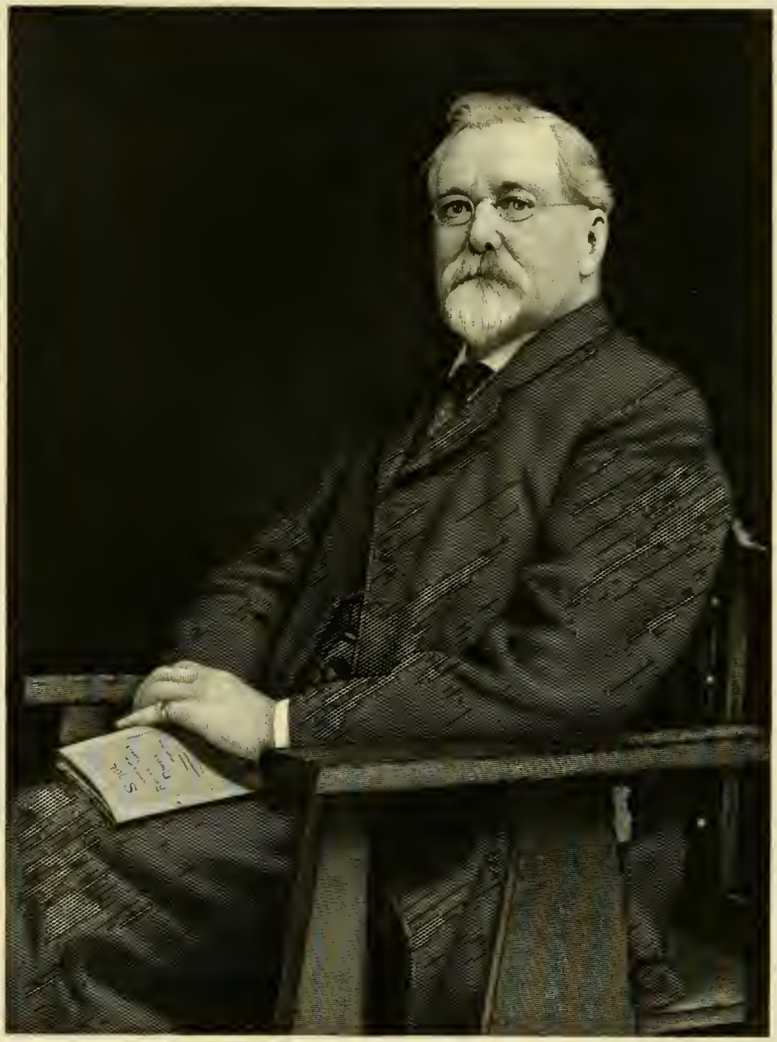
Having spent some time in scientifically studying the cotton fibre, Mr. Kittredge was thoroughly familiar with this line of work, being greatly assisted by his knowledge of the use of the microscope, in which he was a recognized expert..

Combining his literary ability with his knowledge of textile matters, Mr. Kittredge in 1887 began to write on the economic and practical sides of textile manufacturing, and during the remainder of his life was engaged as editor of textile publications and contributor to magazine and technical journals. He became associated with the *Textile World Record,* of Boston, and later was connected with the editorial staff of the *New York Commercial,* which position he subsequently relinquished to become one of the founders of the *Textile American.* In May, 1907, he was appointed editor of *Cotton,* a monthly publication, and the only one known that gives exclusive attention to cotton manufacturing in all of its branches. In addition to his many contributions to magazines and textile journals, Mr. Kittredge read several papers before cotton manufacturers' associations. In 1905 he received the medal of the New England, now National, Cotton Manufacturers' Association, for a paper on the "Economic Extension of Cotton Cultivation in the South."

Mr. Kittredge was personally acquainted with hundreds of American millowners, and was always interested in anything that pertained to the upbuilding of the textile industry. He organized the American Textile Exhibit at the World's Columbian Exposition held in Chicago in 1893, serving as chairman of one of its committees. In 1895 he was chosen by the governor of Massachusetts to represent the Commonwealth at the Atlantic Exposition, together with the Hon. Curtis Guild, Jr., and the Hon. William C. Lovering. Mr. Kittredge was also responsible for the organization of the United States Textile Exhibit at the Paris Exposition in 1900, and selected such exhibits as procured for the manufacturers of this country "Grand Prizes" and "Gold Medals" in all but one instance. The subject of this sketch was a member of the National Geographic Society and was textile technologist for the Century Dictionary and Cyclopedia.

October, 1870, Mr. Kittredge married Martha Sargent, daughter of Samuel and Elizabeth (Sargent) Hodges. After her death in 1881 he married Helen Litchfield in 1883.

After an illness lasting about three days, Mr. Kittredge died in Atlanta, Ga., June 5, 1909, leaving a widow and three children.



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Robt McArthur

JAMES H. LAMB CO.

ROBERT McARTHUR.

Robert McArthur was born in Ashton, England, May 18, 1838, son of John and Jane (Lee) McArthur. The McArthurs were of Scotch and the Lees of English ancestry. Robert McArthur came to New England in 1842, and after a few years' schooling went to work as a bobbin boy in a cotton mill at Woonsocket, R. I., and at the age of nineteen became overseer in a cotton mill at Spragueville, R. I., later holding the same position with the Manville Company, Manville, R. I., and the Social Mills, Woonsocket, R. I. In 1870 he accepted the superintendency of the Millville Manufacturing Company, Millville, N. J., and in 1873 returned to New England to fill the position of agent of the Manchaug Company Mills, Manchaug, Sutton, Mass., where he remained up to 1883. He then accepted a like position with the Grosvenor Dale Company, North Grosvenor Dale, Thompson, Conn., remaining with this company from 1883 to 1886, when he resigned to become agent of the Pepperell Manufacturing Company, Biddeford, Me., which operated over 200,000 spindles and was the largest cotton mill in the State of Maine. The company prospered exceedingly under Mr. McArthur's management, which continued until 1910, when he resigned in order that he might retire from the business altogether.

During the Civil War Mr. McArthur volunteered as a private in the engineer corps of the United States Volunteer Army in 1863 and served till the close of the war, 1865. During his long residence in Biddeford, Me., Mr. McArthur manifested continual interest in the welfare of that city and contributed generously to various objects of public interest. He built the McArthur library building, and also gave $15,000 to the McArthur Library Association, as well as $15,000 to the Webber Hospital. He also gave the McArthur gymnasium building to the Westbrook Seminary at Westbrook, and gave generously to the First Universalist Church and the City Mission. He was elected to membership in the American Society of Mechanical Engineers in 1894, served as president of the New England Cotton Manufacturers' Association for two terms, 1892-94, and of the Textile Club of Boston from 1902 to 1904. He was also a member of all the Masonic bodies and of Post Sheridan, G. A. R., and a member of the famous William Tell Club. He patented a fire extinguisher in 1904, and assigned his rights in that invention to the Kitson Machine Company.

On May 18, 1861, Mr. McArthur married Lydia Ann, daughter of William and Eliza (Paine) Swan, of Smithfield, R. I., and had five children.

ALVIN SUMNER LYON.

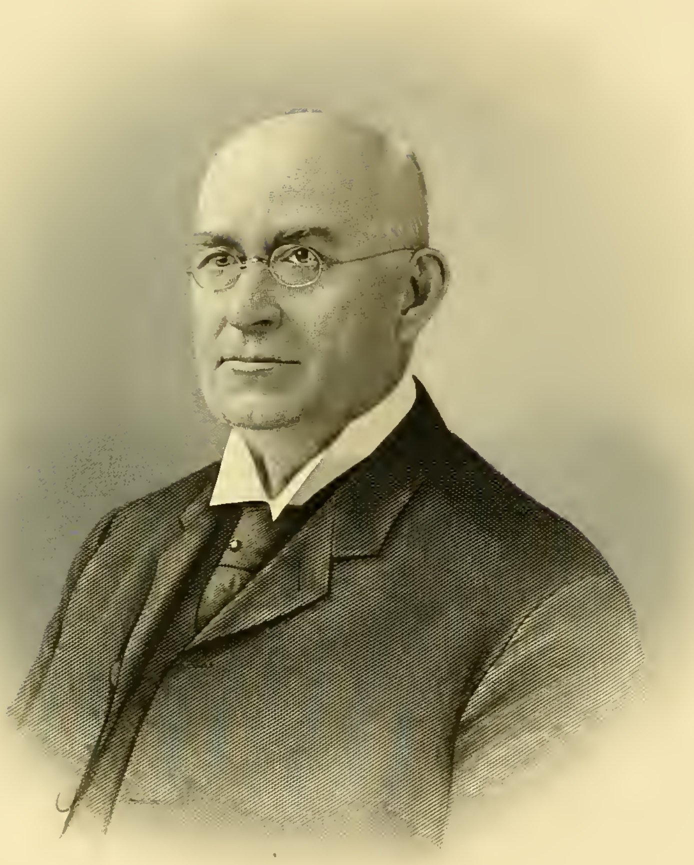
Alvin Sumner Lyon was born in Methuen, Essex County, Mass., March 1, 1840, son of Calvin and Cynthia Lyon; grandson of Ebenezer and Rebecca (Upham) Lyon.

Alvin S. Lyon received his primary instruction in the public schools of Methuen. When nine years of age his father removed to Lawrence, and he there completed his education, and in 1858 entered the Bay State Mills, Lawrence, to learn the wool manufacturing business, his first occupation being the sorting of the wool. Two years later he was given a place in the card room. In 1861 he went to work in the Atlantic Cotton Mills as weaver, and later worked as carder and spinner. From 1868 to 1870 he was in the employ of the Pacific Mills in similar capacities. Thus was he given an opportunity to study the details of the woolen, worsted and cotton manufacturing business, which resulted in his becoming an expert mill man. In 1870 he was made superintendent of the quilt department of the Beaman Mills Company, West Boylston, Mass., and held a similar position in the Bates Quilt Mill, Lewiston, Me., and in the Delaine Mill, Olneyville, R. I. He was also superintendent of the weaving department of the Merchants' Mill at Fall River, and in 1877 was made superintendent of the Crescent Mills, Fall River, and in 1881 of the Durfee Mills. In 1883 he was appointed agent of the Lowell Mfg. Co., and in 1899, when that company consolidated with the Bigelow Carpet Company, of Clinton, under the style of the Bigelow Carpet Company, he was made agent of the new corporation, and held that position until 1906, when he resigned to become agent of the Wood Worsted Mills, at Lawrence. At the time of his death he was one of the oldest mill men in this country, as well as one of the ablest, and received an exceptionally large salary.

He held positions of trust in Lowell as director in the Railroad Bank and the Central Savings Bank of that city, and of the Kitson Machine Company. He was also largely interested in the Lowell Textile School. He was the inventor of machines for skein dying, wool mixing and other labor-saving devices.

Mr. Lyon married, June 16, 1862, Helen, daughter of Edward and Eunice Hogan. Mrs. Lyon died at Lawrence, Mass., Nov. 26, 1906. His son, George A. Lyon, was superintendent of the worsted department of the Bigelow Carpet Company up to 1906, when he became a representative of the Lowell Machine Shop, and in 1907 he organized the Lyon Carpet Company.

Mr. A. S. Lyon died at Swampscott, Mass., Aug. 6, 1907.



Alvin S Lyon

BEVERLY COTTON MILL.

As early as 1640, but more effectually in 1786 and 1787, the General Court of Massachusetts interested itself in introducing into the commonwealth and encouraging the growing of flax and hemp and the breeding and maintaining of sheep, together with the maintenance of factories for the purpose of making cloth of flax, wool and cotton, which articles were mostly supplied by England. This effort was made before the Federal constitution had been adopted, and was a measure taken purely by the Commonwealth of Massachusetts. The legislature offered the usual premiums of prohibitory duties, land grants, the privilege of conducting a lottery and kindred devices for raising money and protecting the infant industry. England had, during the period of the American Revolution, been active in setting up machinery for both spinning yarn and weaving cloth from the fibre of cotton. But up to this time cloth had been produced only through hand labor in the New World, and the cotton used came from beyond the sea, and was imported to be used to mix with linen and sheeps' wool in spinning yarn by hand. The instinct of trade so universal in the New England States suggested the economy of exchanging the most valuable export of that time (fish) for "cotton wool as it grew on trees in the West Indies." This chance for profit was not long allowed to slumber, and John Cabot and Dr. Fisher petitioned the General Court for aid in order to make profitable the manufacture of imported raw cotton. Experiments were tried at various places along the Atlantic coast, to make profitable use of cotton wool, and some of these experiments were made at home and some in rude mills. Some would card by machinery and spin and weave by hand. The fabrics made were generally mixtures of cotton, flax and wool-cotton, with a linen warp producing jeans, —and were woven with the hand shuttle. It was 1788 before South Carolina announced to the world that cotton would grow on her soil and under her genial sun. This was the very year that John Cabot and Dr. Fisher were working on cotton carding and spinning machinery in their mill at Beverly, Mass., with the best prospects of being able in time to produce a finished fabric by machinery, each implement used to be made to do its work by horse power. The legislature of Massachusetts in October, 1786, had appointed Senator Cranch and Representative Bowdoin and other members of the legislature to act as a committee "to view any new-invented machines that are making within the Commonwealth for the purpose of manufacturing sheeps' and cotton wool, and to report what measures are proper for the legislature to take to encourage the same." Models were brought to Boston for the inspection of the committee, each prospective contestant expecting to get valuable aid from the commonwealth, and through the report of this committee a resolve was passed in November, 1786, granting two hundred pounds to enable the brothers Barr, two

Scotch weavers and machinists then at Bridgewater, to perfect the apparatus exhibited for "carding, roping and spinning of sheeps' wool as well as cotton wool," the legislature in a body inspecting the machines after passing the resolve, and commending the public spirit of the inventors allowed their account to the amount of 189 pounds 12 shillings, purchased their models and gave them instead of the promised two hundred pounds six tickets in the land-lottery of 1787.

In March, 1787, the legislature granted the sum of twenty pounds to encourage Thomas Somers, also a Scotchman, to perfect apparatus for carding and spinning cotton, which he had obtained in England in 1785-86, which were, in fact, Arkwright's ineffectually secured patents, and first used at Beverly Cotton Mill. In the latter part of 1788, Cabot, Fisher and their associates had completed a three-story brick building, which they had begun in 1787, 60 x 25 feet, with a pitched shingle roof and a deep basement, in one end of which moved a heavy pair of horses to furnish rotary power.

The following is an extract taken from a quaint letter written by Joshua Herrick to Mr. Batchelder in 1863, which affords an interesting glimpse into the methods of this early industry (see Bagnall):

"There was in said factory a large, old-fashioned carding machine, something like the machines for carding wool, and drawing-heads, something like those used at Wood End, Dover, N. H., and at Brunswick, Me., the whole carried by two large horses turning an upright shaft in a wooden building contiguous to the main building, with a drum-shaft carried into the second story."

In a conversation with Mr. Batchelder the old gentleman further stated that "he drove the horses. They were a large, handsome span of chestnuts, and when he drove too fast Mr. Summers would call out of the window: 'Hold on there! Not so fast! Slower!' and he would hold on; but he would forget the order and drive away, and then he would get a second order to 'hold up!' The mill was fifty feet long, of brick. Nine old women picked the seeds of the cotton, and the cotton was cleaned by men who laid it on a network of cod-line, and whipped it with long sticks."

Further in his letter Mr. Herrick thus describes the machinery: "The last drawing cans were taken into the rear of the billy, a machine that went by hand and made the roping, and operated something like the jenny, excepting the speed of the spindles, which was much slower, and the cops made much larger, and, when doffed, were put on to the wooden spindles or skewers, to set up into the rack of the jenny. There was a slanting feed cloth in the rear of the billy, the lower part of which was a little above the top of the cans, on which the drawing was lapped and rolled by the hand to join it. The jenny had forty spindles, and worked very much like the old-fashioned woolen jenny. The cops were doffed from the spindle as they are now from the mule. If for warp, they were twisted harder and taken

Etched by William P. Bodwell from Sepia Drawing at Essex Institute, Salem, Massachusetts, which was made from Painting in the possession of the Historical Society, Beverly, Massachusetts.

Baker's Tavern and the First Cotton Mill at Upper Beverly [illegible]
Washington's Visit Octob. [illegible] 178[illegible]

to other wheels to be wound on spools; if for filling, it was twisted slack and taken to the winder of bobbins for the shuttle. . . . .

"I never heard of the 'spring-shuttle.' They were called the 'fly-shuttle' at the old factory. The box for the shuttle was put on to the lathe that hung from the top of the loom, and had pickers, like those of the power looms. The weaver had a handle in his right hand with strings to each picker; when he swung his lathe back, he threw his shuttle through the woof into the opposite box; and for any common goods he brought his lathe against the filling but once. . . . . Corduroys, velvets, thicksetts, and jeans, were manufactured at the old brick mill."

"The building, the first put up in America as a cotton mill, was erected on Bass River on a lot on the road from Mr. Oliver's Meeting House to Beverly Ferry, which they had purchased from Josiah Batchelder, Esq., and Hannah, his wife, by deed dated Aug. 18, 1788. The legislature was petitioned in June, 1788, for an act of incorporation for the manufacture of cotton, the principal part of the labor to be performed by machinery, many of the machines being applicable to the manufacture of silk, hemp, flax and wool; to afford employment to a great number of women and children, etc. The signers to the petition were: John Cabot, George Cabot, Deborah Cabot, Andrew Cabot, Moses Brown, Nathan Dane, Joshua Fisher, Thomas Somers, Israel Thorndike, James Leonard, Henry Higginson and Isaac Chapman. This petition was referred to a sitting of the General Court in January, 1789, and on February 3, 1789, the adventurers procured a charter, an endorsement of their enterprise, and a great aid for encouraging the cotton manufacturing at Beverly.

As early as April, 1788, the Salem *Mercury* announced that the Cabots had procured a complete set of machinery for carding and spinning cotton, the spinning jenny spinning sixty threads at a time, and by the carding machine "forty pounds of cotton can be well carded in a day;" the warping machine and other tools, part of which go by water, are all complete, performing their various operations to great advantage and promise much benefit to the public, and emolument to the patriotic adventures." The Salem *Mercury* of May 6, 1788, contained the following notice: "The artists who introduced into Beverly the machines for carding and spinning cotton are Mr. Leonard and Mr. Somers, who were regularly bred to the making and finishing of velvets, corduroys, jeans, fustians, demins, Marseilles quiltings, dimity muslins, etc. With such talents they supposed that the risk and expense of coming to this country would be amply recompensed by the encouragement such valuable manufactures deserve. But they made various applications with no other effect than loss of time and money. Such difficulties, co-operating with the want of energy and system in our government, reduced them to the disagreeable necessity of resolving to leave a country so unpromising to manufacturers, when the Hon. George Cabot generously patronized them

and influenced a number of gentlemen of Beverly to associate for the purpose of establishing these much wanted industries. These gentlemen merit the thanks of their fellow-citizens." On Jan. 6, 1789, the same newspaper mentions a promising cotton manufactory in Beverly. Apprentices to the business of attending the machinery were received as early as June, 1789, and in 1790 the Beverly Mill sent out a mechanic to set up machinery in a Connecticut cotton mill. On Oct. 30, 1789, President Washington, then on a journey through the New England States, took breakfast with George Cabot, subsequently United States Senator from Massachusetts and first secretary of the United States navy, at his home in Beverly. The president had left his coach at the Wood Mansion, Salem, and, by invitation of his friend and long-time correspondent, he proceeded on horseback to inspect the draw of a just completed bridge which Cabot had promoted, and after breakfast at the Cabot mansion he rode on to the cotton mill, where he was greeted by the young women employed in the mill, reinforced by their friends, and he thoroughly examined the process of manufacture and witnessed the operation of the rude machinery. The distinguished visitor, after slaking his thirst at the well, took his departure in his travelling carriage for Newburyport and Portsmouth.

Washington, in his journal of Friday, October 30, thus describes this visit:

"After passing Beverly 2 miles, we come to the Cotton Manufactory, which seems to be carrying on with spirit by the Mr. Cabbots (principally). In this manufactory they have the new Invented Carding and Spinning machines; one of the first supplies the work; and four of the latter; one of which spins 84 threads at a time by one person. The Cotton is prepared for these machines by being (lightly) drawn to a thrd, on the common wheel; there is also another machine for doubling and twisting the threads for particular cloths; this also does many at a time. For winding the Cotton from the Spindles and preparing it for the warp there is a Reel which expedites the work greatly. A number of Looms (15 or 16) were at work with spring shuttles, which do more than d'ble work. In short, the whole seemed perfect, and the Cotton stuffs, w'ch they turn out, excellent of their kind; warp and filling both are now of Cotton."

February 17, 1789, the legislature passed a "Resolve for encouraging the Cotton Manufactory at Beverly," by which land to the amount of five hundred pounds was granted to "the Proprietors of the Beverly Cotton Manufactory." Finding this grant insufficient for their purposes in 1791, they made further application with the following result:

Refolve on the petition of the proprietors of the *Beverly* Cotton Manufactory, granting them feven hundred tickets, in the Semi-annual State Lottery—on condition.

Paffed, *March* 4, 1791.

Whereas, the manufacture of Cotton, as undertaken by the proprietors of the *Beverly* Cotton Manufactory, continues to need the aid of Government for its fupport and effectual eftablifhment, notwithftand-

ing the fpirited exertions of the faid proprietors; and it appearing to be of great importance to this Commonwealth, that the faid manufacture fhould be purfued:

Refolved, That there be, and is hereby granted to the faid proprietors, four hundred tickets of the prefent State Lottery, called the Semi-annual Lottery; and alfo three hundred tickets more to be received from the next lottery or clafs, which fhall be undertaken by the managers of the State Lottery, of the fame price:—and the faid Managers are hereby directed and authorized, to deliver the faid Proprietors, their Treafurer, Agent, or Committee, the faid 400 tickets, from the Lottery now in hand; and the faid three hundred tickets, from the faid next lottery, or clafs, as foon as may be, after the fale thereon fhall be commenced; taking two receipts of the faid Treafurer, or other perfon, to whom the fame fhall be delivered, or the ufe of the faid Proprietors, upon each delivery, the one of such receipts to be lodged with the Treafurer of this Commonwealth; and the other to be retained by the Manager or Managers, who fhall deliver the fame.

Provided, and it is further *Refolved,* That the faid Proprietors, by their Corporate Name, fhall become bound to this Commonwealth, in the fum of *three thousand pounds* in a bond, to be delivered to the Treafurer, and to be conditioned, that the faid proprietors fhall, for at leaft feven years now coming, continue to profecute the faid manufacture at *Beverly,* or elfewhere, under the immediate direction of the faid Proprietors, their Agents or Servants; and fhall employ therein, with all reafonable care and induftry, at leaft their whole prefent ftock; and alfo after the firft day of *July* next, an additional fum of *twelve hundred pounds;* and fhall deliver with the faid bond, to the Treafurer, a correct inventory of their faid prefent ftock.

The fabrics produced at the Beverly Mill, including corduroys, royal ribs, thick setts, stockinette and rib deliveries, were on sale in Beverly, Salem and elsewhere in Massachusetts in 1789 and in 1790, "the wear of the Beverly corduroys had become very common." According to a letter from George Cabot to Alexander Hamilton, dated Beverly, Sept. 6, 1791, the Beverly Cotton Mills at that time had in operation machinery as follows: 'One carding-engine, which, with the labor of one man, cards fifteen pounds per day and with the labor of two men is capable of carding thirty pounds per day; nine spinning jennies of 60 and 84 spindles each; one doubling and twisting machine, constructed on the principle of the jenny; one slabbing machine or coarse jenny, to prepare the ropings for the finest jennies, wherein they are fitted for doubling and twisting; one warping-mill sufficient to perform this part of the work for a very extensive manufactory; sixteen looms with flying shuttles, ten of which are sufficient to weave all the yarn our present spinners can finish; two cutting frames, with knife guides, etc.; one burner and furnace, with apparatus to singe the goods; apparatus for coloring, drying, etc." Of the forty persons employed in the factory, thirty-nine were natives of the vicinity of the mill. The venture never proved profitable, and the statement to Alexander Hamilton showed a loss of $5,000, which the

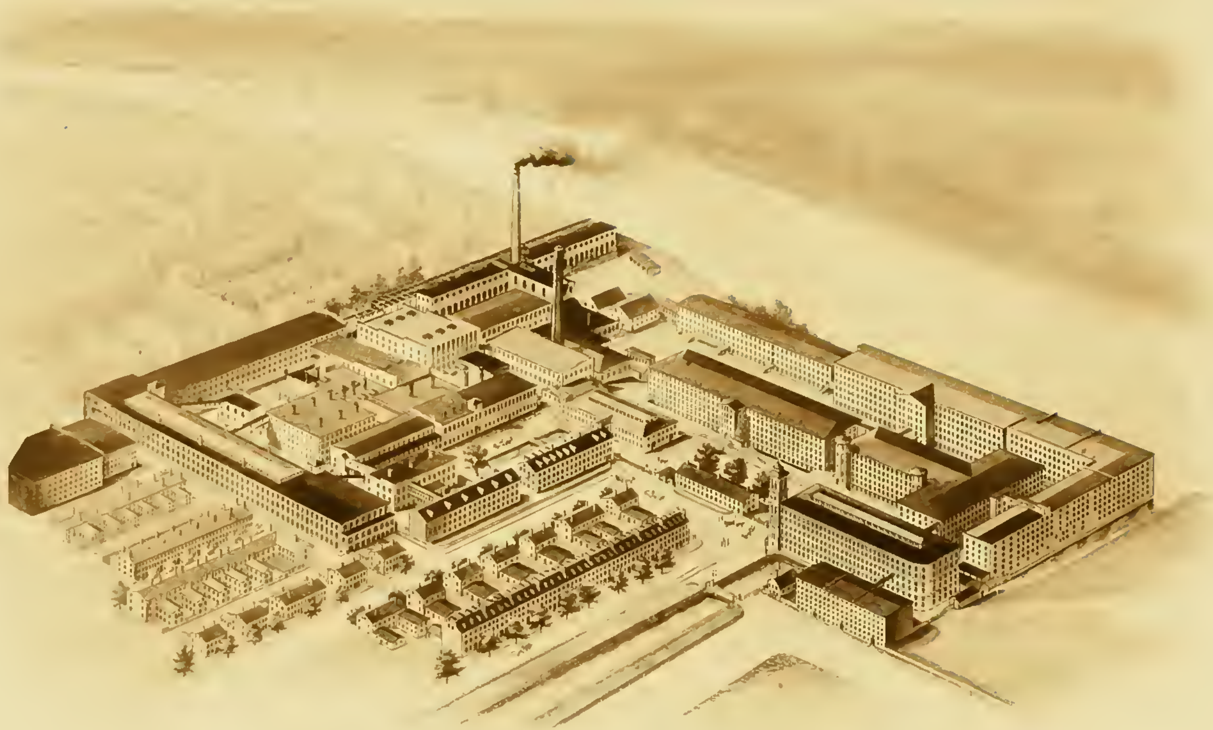
proprietors hoped to make up partially by the sale of $4,000 in land and lottery tickets granted by the legislature of Massachusetts. The experience gained in this early venture was turned to good account by the proprietors of subsequently founded cotton mills.

The Salem *Gazette* of Oct. 14, 1828, says: "The brick factory, with the barn and sheds attached to the Baker Tavern in Beverly, was burnt down and the tavern was on fire when the Eastern stage came through Beverly last evening." And the Essex *Register* of the 16th adds: "The fire first started from the chimney of the Tavern just before dark during a violent gale, and consumed the brick building near by, formerly used as a cotton factory." A brick meeting-house was erected in 1829 at Beverly Farms, and the venerable Deacon Haskell was one of a party of young men who at that time visited the ruins of the cotton mill at upper Beverly, where they cleaned the bricks and removed them to the Farms to be used in building the village meeting-house.

MERRIMACK MANUFACTURING COMPANY.

"The Proprietors of the Locks and Canals on Merrimack River were chartered by the General Court of Massachusetts, June 27, 1792, to provide navigation from the north line of the State to the sea; but in the following year a charter was granted to the Proprietors of the Middlesex Canal for connecting the Merrimack River above Pawtucket Falls with Medford River, and two years later an additional act granted the right to continue this canal to Boston. This rendered the completion of navigation down the Merrimack River of little importance, and the work of the Proprietors of the Locks and Canals on Merrimack River was limited to passing Wicasse Falls by a single lock and passing Pawtucket Falls by five locks, and a canal one and three-quarters miles long, with a fall of thirty-two feet. This is believed to be the first canal in America in which boats were lifted from one level to another when floating in the lock. Its charter was dated but thirty-three years after that of the Bridgewater Canal in Lancashire, England, which was the commencement of the British Barge Navigation.

"Patrick T. Jackson, Nathan Appleton and others, who, with Francis C. Lowell, in 1814, commenced cotton manufacture at Waltham, on the Charles River, found in 1821 that their waterpower was all in use, and desiring to extend their business and introduce into the country the manufacture and printing of calicoes, they purchased the stock of the canal company and a large area of land adjacent to the canal, near Pawtucket Falls, in the town of Chelmsford, and were chartered under



Merrimack Manufacturing Company,

Lowell Mills.

JAMES H. LAMB Co.

Merrimack Manufacturing Company.

Huntsville Ala. Mills.

the name of the Merrimack Manufacturing Company, Feb. 5, 1822, with a capital stock of $600,000.

"The shares of the canal company were conveyed to the directors of the manufacturing company in trust, so that the old organization was continued.

"The Merrimack Manufacturing Company found it necessary for its own use to build a dam across the river, to enlarge the old Pawtucket Canal and build a branch canal. This being accomplished, they, in 1825, sold all of the land and waterpower not required for their own purposes to the Proprietors of the Locks and Canals on Merrimack River.

"The latter company made the necessary new canals to bring the water power into use. They laid out the town and built many of the streets and the necessary bridges. The Merrimack Manufacturing Company built St. Anne's Church in 1824."

The above extract conveys an idea of how the Merrimack, the pioneer manufacturing enterprise of Lowell, began. The stock of the corporation was distributed among Kirk and J. W. Boott (180 shares), Nathan Appleton (180 shares), P. T. Jackson (180 shares) and Ruel Moody (60 shares). The first officers of the corporation were: Kirk Boott, treasurer of the corporation, and for one year superintendent of the Print Works; Allan Pollock, 1823, superintendent of the Print Works; Ezra Worthen, superintendent of the spinning and weaving departments in 1823; Warren Colburn in 1824, and Kirk Boott from 1825 to 1833, when John Clark became superintendent. He in turn was succeeded, in 1848, by Emory Washburn; in 1849 by Edmund L. LeBreton; in 1850 by Isaac Hinckley; in 1865 by John C. Palfrey; in 1874 by Joseph S. Ludlam, who also became agent; in 1896 by John W. Pead, and in 1904 by J. C. Wadleigh.

The mills of the company were located on lands transferred by Thomas M. Clark and other purchasers or owners to Kirk Boott, John W. Boott, Nathan Appleton, Patrick T. Jackson and Paul Moody, and by them to the Merrimack Manufacturing Company. The first water-wheel of this company was set in motion Sept. 1, 1823, and to them is due the credit of introducing into America the business of printing calicoes. While it is probable that a company in Dover, N. H., and one in Taunton, Mass., had started actual operations for the conducting of this industry a short time before the plant of the Merrimack Company was set in motion, yet, nevertheless, it was the latter company who first conceived the idea of establishing this trade in America. They are also recorded as being the first in this country to use the cylinder rollers, the printing of calicoes having previously been accomplished by the use of hand blocks.

Allan Pollock continued as superintendent of the Print Works until 1826, when he was succeeded by John D. Prince, of Manchester, England. The latter held office until 1855, when Henry Burrows succeeded him. In

1875 James Duckworth became superintendent, and in 1882 Robert Leatham, who was followed in 1885 by his brother, Joseph Leatham; and he in 1887 by John J. Hart. Mr. Boott died in 1837, and the treasurership was held by Francis Cabot Lowell for two years, 1837-39; and in 1839 Eben Chadwick was elected and served for fifteen years. Francis B. Crowninshield was treasurer, 1854-77; Arthur T. Lyman and Augustus Lowell for short terms in 1877; Charles H. Dalton, 1877-89; Howard Stockton, 1889-1900, when he was succeeded by Charles L. Lovering, who held office until his death on May 5, 1908, when he was succeeded by Herbert Lyman.

PROGRESSION OF THE BUSINESS.

In 1911 the capital stock was $4,400,000, and the equipment of the seven mills then in operation in Lowell, Mass., comprised 4,367 looms, 155,376 spindles, and 23 printing machines. The company also occupied a three-story building, 344x 128 feet, and a five-story building, 437 x 130 feet, in Huntsville, Ala. The equipment of the southern plant included 318 cards, 92,480 spindles, 2,281 looms, "narrow;" 400 40-inch looms, one Hamilton-Corliss Engine, 2,500 horsepower, and one American & British Manufacturing Marine Type Engine, 1,500 horsepower. The goods produced by the Merrimack Manufacturing Company include fancy prints, plain and fancy wash goods, mercerized goods, corduroys and velvets. Besides the waterpower obtained from seven water-wheels the company at Lowell installed seven large engines of the Green-Wheelock, Buckeye and Corliss patterns, of from 500 to 2,500 horsepower, the entire steam and waterpower aggregating 10,000 horsepower.

In 1911 the officers of the corporation were: Arthur T. Lyman, president; Herbert Lyman, treasurer; J. C. Wadleigh, agent; Avery B. Clark, superintendent of Mills; Percy Gulline, superintendent of Print Works; Herbert B. Lincoln, clerk; Arthur T. Lyman, George Wigglesworth, Charles F. Ayer, Jacob Rogers, Arthur Lyman, James Arnold Lowell and Herbett Lyman, directors; and Lawrence & Co., selling agents; and Arthur W. Hunking, 1900; George T. Marsh, 1901; and Joseph S. Bradley, agents at the Alabama factory.

The sales of cloth for 1909 were over 87,000,000 yards, valued at nearly $6,500,000. There were over 4,000 people employed by the company.

THE LAWRENCE MANUFACTURING COMPANY.

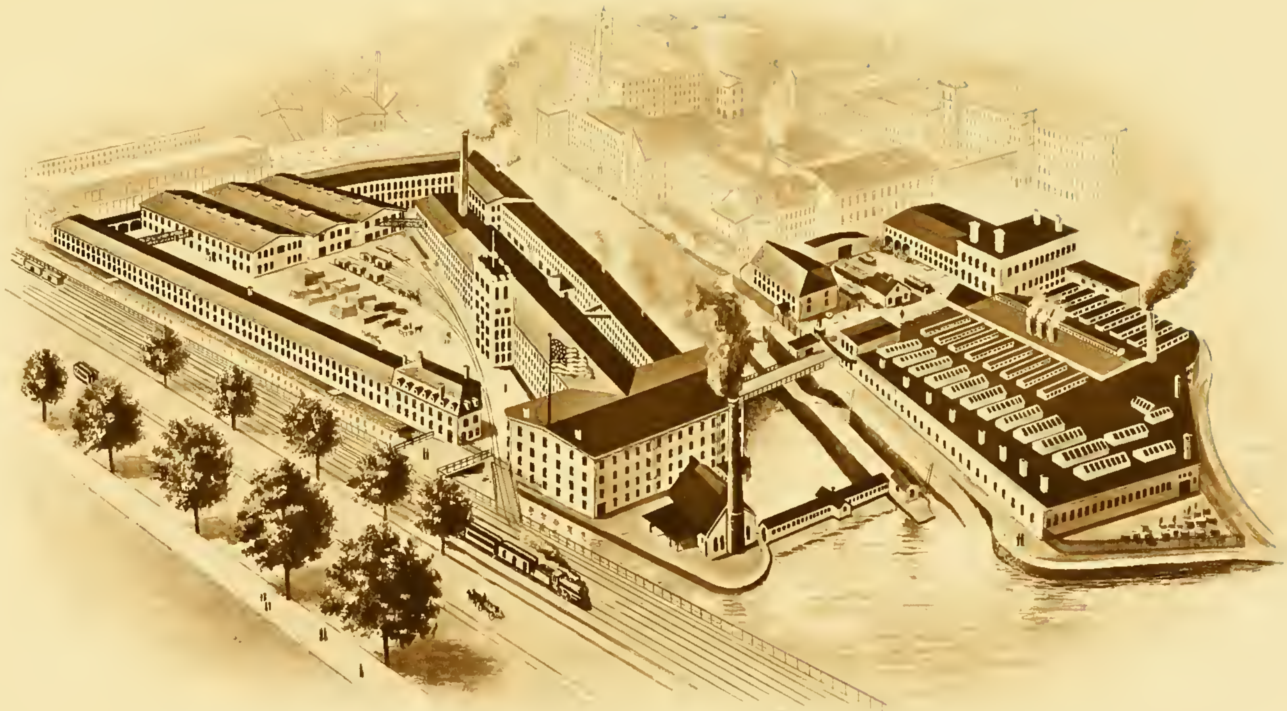
The Lawrence Manufacturing Company, Lowell, Middlesex County, Mass., on the Merrimac River and the Boston and Maine Railroad, was projected in June, 1831, by A. & A. Lawrence, commission merchants of Boston, and their associates, who had been instrumental in beginning the cotton industry at Lowell. The corporation known as the Lawrence Manufacturing Company was incorporated by the legislature of the State of Massachusetts, June 7, 1831, the capital stock of the corporation being fixed by the charter at $1,200,000, and increased and decreased from time to time, and in 1910 was $1,250,000. The first board of directors elected Thomas H. Perkins president and William Appleton treasurer, the latter serving only through the passage of the act of incorporation, being succeeded in 1832 by Henry Hall, who served as treasurer for twenty-five years. In 1835 Amos Lawrence was elected president of the corporation, but he served only one year, and in 1836 was succeeded by Thomas B. Wales, who held the office for seventeen years. Abbott Lawrence served from 1853 to 1855, and he was succeeded by Ignatius Sargent, who served from 1855 to 1859. William Appleton was president from 1859 to 1861, and John A. Lowell 1861 and part of 1862. Ignatius Sargent was elected temporarily in 1862, and regularly in 1863. John A. Lowell followed Mr. Sargent, serving 1864-67. George H. Kuhn was president of the corporation, 1867-74, followed by J. Huntington Wolcott, 1874-82; T. Jefferson Coolidge, 1882-92; W. Powell Mason, 1892-94, and T. Jefferson Coolidge from 1894-1910. After Mr. Henry Hall's service as treasurer, the office was filled by Henry V. Ward for eleven years, 1857-68; by T. Jefferson Coolidge twelve years, 1868-80; by Lucius M. Sargent thirteen years, 1880-93, and in 1893 Clifton P. Baker was elected treasurer.

In 1896 the capital stock was reduced to $750,000, as the corporation had given up the manufacture of cloth. In 1901 the capital was increased $500,000 by the issue of a stock dividend, making it $1,250,000. Originally the mills were devoted entirely to the manufacture of coarse cotton cloth, but in 1864 the knitting of stockings and underwear was introduced in a small way, and, after 1896, when the weaving of cloth was discontinued, the looms and a portion of the spindles used in spinning yarns for cloth with the portion of the plant devoted to that industry was sold, the remaining mills being devoted to the manufacture of cotton hosiery. The entire plant in 1910 included seven distinct mills with storehouses, dyehouses, machine shop, and the numerous other buildings required. The officers of the corporations, with offices at 58 Ames Building, Boston, were: T. Jefferson Coolidge, Jr., president; Clifton P. Baker, treasurer and general manager; Everett H. Walker, agent at the mill, and F. A. Wilcox, clerk; and the Board of Directors included the president and treasurer, George Gardner, Arthur T. Lyman,

T. Jefferson Coolidge, Henry B. Cabot, Charles W. Amory, Franklin Nourse and Francis W. Sargent. The mills gave steady employment to nearly 4,000 hands, and consumed annually 20,000 bales of American and Egyptian cotton. The company, besides making the yarn and thread used in its own manufacturing operations, sold over 25,000 pounds weekly. It operated 111,000 spindles, over 100 combers for its high grade yarn, more than 2,400 knitting machines and 1,000 sewing machines. Its box shop turned out over 62,000 paper boxes each week, and for packing cases used 2,250,000 feet of lumber per annum. For the year ending April 30, 1910, the product of underwear amounted to 959,695 dozen, and of hosiery 1,030,476 dozen. E. M. Townsend & Co., of New York, Boston, Philadelphia and Chicago, were selling agents for the company.

THE LOWELL MACHINE SHOP.

The British Stamp Act of 1765 threw the American people upon their own resources politically. The British "Act to prevent the exportation to foreign parts of the utensils made use of in the cotton, linen, woolen and silk manufactures of this Kingdom," enacted in 1774, threw them upon their own resources industrially. The forty years which followed that enactment witnessed the invention of the cotton-gin by Eli Whitney, an American, and the introduction into the English textile industries of the steam-engine and of power-driven carding, spinning and weaving machinery; but the transfer of those foreign inventions to the United States was attended with grave difficulties. Nevertheless, partly by memorizing the nature of the English machinery and partly by invention, power-driven carding and spinning machinery had been successfully introduced into the United States before the War of 1812. In 1811 Mr. Francis C. Lowell, of Boston, being temporarily in Great Britain, was attracted by the efforts which were there being made to improve upon power-driven weaving machinery. He returned to Boston, two years later, with an excellent knowledge of the English machinery and of its uses, and, associating himself with others, notably with Mr. Patrick T. Jackson and Mr. Nathan Appleton, who were capitalists of Boston and who actively interested themselves in financing and managing the new enterprise, and with Mr. Paul Moody, of Amesbury, who was a skilled and reputable mechanic, for the first time in history systematically converted cotton into cloth within the walls of a single building. Mr. Lowell experimented with his first power-loom at a store in Broad Street in Boston, but it was ready for trial only upon the completion of the new mill building at Waltham. By the united efforts of Mr. Lowell and Mr. Moody, one variety after another of successful textile machines were developed and manufactured, until the sum of four hun-



Lowell Machine Shop

JAMES H LAMB CO.

dred thousand dollars had been expended, and the art of manufacturing cotton cloth from baled cotton within a single building under a single management had been successfully initiated. The profits of this undertaking created a demand for its extension. The water power of the Merrimack River at the Pawtucket Falls was purchased. The Merrimack Manufacturing Company was formed to manufacture cotton goods in 1823, and a machine shop of the exact size of the most approved building for the manufacture of cotton cloth was constructed by it upon the banks of the Merrimack and Pawtucket Canals in East Chelmsford, now Lowell, with the intention of constructing therein the machinery for the equipment of the Merrimack Manufacturing Company's Mills, and then, when there would be no longer a use for such a shop, of converting it into a cotton manufactory. The patent rights and the use of all of the patterns of the Waltham machinery were acquired, and the new shop was managed by Mr. Moody from the beginning until his death in 1831. In 1825 the proprietors of the locks and canals on Merrimack River purchased the machine shop with such rights and use, and continued to supply the necessary machinery to each new mill which was constructed until 1845, when an independent corporation, called the Lowell Machine Shop, was formed, which purchased the machine shop property and business.

The original machine shop building is still standing, and it has been continuously used for machine construction. Mr. George Brownell, an expert machinist who had learned the business in the Waltham Machine Shop and had afterward engaged in manufacturing cotton machinery in Fall River, was induced by Mr. Paul Moody to come to the shop of the Merrimack Manufacturing Company, and to remain when it was transferred to the proprietors of the locks and canals; and, after the death of Mr. Moody, Mr. Brownell remained as superintendent until the property was sold to the Lowell Machine Shop. In the beginning the shop had no foundry, and as late as 1835-37 its castings were being purchased of Captain Lincoln Drake, of North Chelmsford. In 1840, it is said, thirty thousand dollars ($30,000) were expended upon a foundry. The Lowell Machine Shop was incorporated by John A. Lowell, Abbott Lawrence and Nathan Appleton, with an authorized capital stock of five hundred thousand dollars ($500,000). When it began operations, three hundred thousand dollars (300,000) had been paid in. On Feb. 5, 1848, the legislature authorized an increase in the capital stock to one million of dollars ($1,000,000). An additional three hundred thousand dollars ($300,000) was paid in 1848, and another three hundred thousand dollars ($300,000) in 1881. On March 12, 1845, the stockholders elected: J. Thomas Stevenson, treasurer; William Alvord Burke, superintendent, and Patrick T. Jackson, executive manager. Mr. Burke was a machinist who had served his time at the Nashua Manufacturing Company's shops at Nashua, New Hampshire. At the age of twenty-three he was placed in charge of the machine

shops of Ira Gay and Company, of Nashua, and when twenty-five he became master machinist of the Boott Cotton Mills, where he remained for four years. In 1839 he became agent of the Amoskeag Machine Shop at Manchester, N. H. He remained sixteen years at the Lowell Machine Shop as its superintendent, and saw the establishment develop into the most extensive works in the United States devoted to the manufacture of machinery used in the production of plain cotton cloth.

It was as essential that these newly organized cotton manufactories should be provided with power-producing and power-distributing plants as with textile machines. It was, therefore, necessary for the machine shop which had been initiated by the Merrimack Manufacturing Company to construct the water-wheels which were to utilize the power of the Merrimack River. This was begun by Mr. Paul Moody, who was guided by the principles which had been laid down by Smeaton, the eminent hydraulic engineer. Later, Mr. Uriah A. Boyden, an American engineer, invented an improved form of the turbine water-wheel. It was less costly of construction, occupied much less space, rotated more rapidly, and therefore more nearly at the speed desired for the shafting, and was much more efficient than the Smeaton-Moody wheels. These Boyden wheels were constructed here, and rapidly replaced the others. At a still later date, Mr. Asa M. Swain, a pattern-maker of the Lowell Machine Shop, who was employed in the making of patterns for the Boyden turbines, invented an improved turbine which was smaller, more rapid, less costly and, under some conditions, more efficient than the Boyden turbine, and it replaced the latter. Upon the formation of the independent Swain Turbine and Manufacturing Company, the Lowell Machine Shop gladly transferred its energies from the manufacture of water-wheels and devoted them more strictly to the manufacture of textile machinery. This is only a single illustration of a principle which has continually found application in the history of this shop.

At first the power was distributed by means of heavy slowly moving shafting and gearing, in accordance with the English system. Later, in 1828, when the equipment of the Appleton Mills was being undertaken, Mr. Moody cut loose from established precedents, and substituted for such shafting and gearing lighter and more rapidly moving shafting with pulleys and belting. This substitute power-distributing machinery was cheaper to construct and wasted less power in the distribution, and there has been no return to the English system. When Mr. W. W. Carey equipped a machine shop at Lowell with modern appliances for producing power-distributing machinery, appliances which were sufficiently extensive to meet promptly the needs of manufacturers, the Lowell Machine Shop simplified its plant and its management by giving up this phase of its business, but improved its facilities for the more satisfactory and rapid production of the best textile machinery. In June, 1835, the Boston and Lowell Railroad was

opened for travel. Locomotives were needed and were manufactured by this shop, which was the first to produce locomotives in New England. This manufacture was given up during the sixties, when the independent locomotive shop had gained a permanent and profitable foothold in the United States. At an early date this shop began to supply paper mills with the necessary equipment of paper machinery, and continued to do so until the death, in 1891, of Mr. Wyllis G. Eaton, who had managed the business for the shop. Space will not permit even a condensed recital of the history of the manufacture by this shop of stationary steam-engines and boilers and of many another class of machinery which was necessary to the rapidly developing industries of the country, while as yet the manufacture of such class of machinery had not developed sufficiently to meet the public need without calling upon the resources of the "Big Shop."

With a continuity of purpose which resembles the onflow of the Merrimack, the Lowell Machine Shop has ever sought to diminish its production along other lines, that it might more completely devote its energies to, and develop its facilities for, the profitable manufacture and sale of, and increase its output of, textile machinery of approved excellence. Without counting its tenements, it has twenty-one separately designated buildings, having a united floor area of fourteen acres within its yard and devoted to the manufacture. It not only manufactures cotton, but also worsted and silk machinery. The prospect of converting the shop into a cotton manufactory never seemed more remote than it does to-day.

The most valuable output of this shop has been its men. There is something in a brain-and-hand conflict with iron and steel, with intense heat, with irresistible water and steam and compressed air and electrical power, with the delicate Midas-touched problems of the textile industry; and with the safeguarding and the profit-producing use of an immense sum of money, which naturally inspires the healthy, vigorous, untrained New England lad, the workman from every land, the skilled mechanic, draughtsman, inventor, engineer, the trained man of science or of business, the organizer, the manager, and even the chief executive, to do his best. The worker develops with his success in conflict. It increases his breadth of view, and his value as a producer, as a citizen, and as a man. Many a human transformation has occurred within its walls, many a vigorous intelligence has made a lifelong and permanent impression upon the problems of the shop, or has gone hence to wrestle successfully with other industrial difficulties upon the recommendation of its officials or of others. The establishment of a high-grade free school of industrial drawing by the city of Lowell, of almost free courses of instruction in the textile industries in the Lowell Textile School, the greaty extended curriculum of the Lowell High School, and the lavish provisions for physical and intellectual training in neighboring colleges and technical schools have increased the opportunities for the development of energetic young men of the Lowell

Machine Shop, who wish to be capable of doing the world's best work. Increasing capital, wisely invested, carefully safeguarded, utilized to the limit by wise, intelligent, industrious workers, will continue to develop manhood and will influence the future of industrial America even more than it has its past.

The successive presidents have been John A. Lowell, Homer Bartlett, George H. Kuhn, J. Huntington Wolcott, Augustus Lowell, Arthur T. Lyman, and in 1911, Robert F. Herrick.

The successive treasurers have been: J. Thomas Stevenson, 1845-76; William Alvord Burke, 1876-84; Robert H. Stevenson, 1884-88; Charles Lawrence Peirson, 1881-91; Robert H. Stevenson, 1891-1905; Haven C. Perham, from 1905.

The successive superintendents have been: William Alvord Burke, 1845-61; Mertoun C. Bryant, 1861-62; Andrew Moody, 1862-70; George Richardson, 1870-79; Charles L. Hildreth, 1879-1905; Albert H. Morton, from 1905.

DRAPER COMPANY.

The business of this corporation, which is largely devoted to the development, manufacture and sale of patented improvements in cotton machinery, dates back to the year 1816, when the first patent was granted to Ira Draper for improvements in looms and loom temples. James Draper, son of Ira, continued the business, and another son, Ebenezer D. Draper, transferred it to Hopedale in 1842, where it has since been located.

In 1852 George Draper, brother of E. D. Draper, joined with him in forming the partnership of E. D. & G. Draper. The patenting of the reciprocating loom temple by E. & W. W. Dutcher in 1852 led to the purchase of Elihu Dutcher's interest by the Drapers in 1854 and the formation of the partnership of W. W. Dutcher & Co. for the manufacture of Dutcher temples. In 1856 this business was moved to Hopedale. In this year also, on the giving up of its business operations by the Hopedale Community, the Drapers joined with Joseph B. Bancroft in forming the Hopedale Machine Company, a partnership, manufacturing various patented improvements in cotton machinery, sold by E. D. & G. Draper.

The Hopedale Furnace Company was organized in 1856 as another partnership, to furnish castings used in the Hopedale industries.

In 1867 the corporations of the Hopedale Machine Company and Hopedale Furnace Company were organized to replace the partnerships under same names, and the Dutcher Temple Company succeeded the firm of W. W. Dutcher & Co.

In 1868 William F. Draper, son of George Draper, purchased the

SKY PHOTOGRAPH OF DRAPER COMPANY WORKS.

JAMES H LAMB Co

interest of E. D. Draper in the firm of E. D. & G. Draper, and the name was changed to Geo. Draper & Son. This became George Draper & Sons in 1877 by the admission of George A. Draper. Later Eben S. Draper, William F. Draper, Jr., and George Otis Draper were admitted to the firm, the name remaining the same.

In 1892 the Northrop Loom Company was organized to develop the inventions of James H. Northrop, Charles F. Roper and others in automatic looms. In 1896 the corporation of Draper Company was organized by consolidation of the Hopedale Machine Company, Dutcher Temple Company, Hopedale Machine Screw Company, the United States interests of the Northrop Loom Company and the firm of George Draper & Sons. William F. Draper was chosen president; Joseph B. Bancroft, vice-president; George A. Draper, treasurer; Eben S. Draper, agent; George Otis Draper, secretary; Eben D. Bancroft, purchasing agent; Frank J. Dutcher, assistant agent, and Charles M. Day, general superintendent.

The growth of the business in Hopedale was from the little shop planted there in 1842 by Eben D. Draper to the largest cotton machinery plant in America, with a floor space of nearly thirty acres and engines representing about three thousand horse-power. Its foundry is the largest in New England. The company has given employment to 3,000 workmen, and has a capacity for the employment of 5,000. Around this plant has grown up a model country village. Exhibits of its houses have repeatedly received awards at expositions both in this country and abroad. Trolley cars connect it with Boston, 34 miles; Providence, 26 miles; Worcester, 19 miles; Uxbridge, 7 miles, and Woonsocket, R. I., 13 miles. It has ample railroad facilities, connecting with both the New York, New Haven & Hartford and the New York Central systems.

Among the important inventions which have been handled by this company and its predecessors are the various types of modern high-speed spindles, of which over 32,000,000 have been sold directly or through licenses, and which have doubled the product of the cotton mills per spindle with but little added cost for labor; the double flange spinning ring, of which about 25,000,000 have been sold; the Northrop loom, which is saving over $6,000,000 per annum to the mills on the looms sold up to January, 1910; the Dutcher temple, which has become the standard for all classes of cotton weaving; the cone warper, Wade bobbin holder, Rhoades-Chandler separator, etc. The company also became the makers of twisters, spoolers, banding machines and various special attachments for all the above.

Hopedale inventors have added to the perfection of machinery for cotton manufacturing, and patrons of the Draper Company have the benefit of the best thought and experience of workmen and officials, thereby insuring the latest and best of everything in the line of goods produced.

In 1911 the officers of the company comprised: Frank J. Dutcher, presi-

dent and secretary; Eben D. Bancroft, vice-president and purchasing agent; George A. Draper, treasurer; Eben S. Draper, agent; W. I. Stimpson, assistant agent; C. E. Nutting, general superintendent; J. D. Cloudman, Southern agent; and the capital stock of the company was $8,000,000, of which $6,000,000 was common and $2,000,000 preferred stock.

HAMILTON MANUFACTURING CO.

The plant of the Hamilton Manufacturing Company is situated at Lowell, Mass., on the Merrimac River, and its factories, storehouses and other buildings and boarding houses and tenements cover a space of nearly eight acres. The land and water power of the Hamilton Manufacturing Company was the first sold by the "Proprietors of Locks and Canals Company," and it was the second of the great system of factories that has sprung from that parent enterprise.

The Hamilton Company was incorporated in 1825 by Samuel Batchelder, Benjamin Gorham, William Appleton, Wm. Sturgess and John Lowell, Jr., with a capital of $600,000, which was increased to $800,000, May, 1828; to $900,000, June, 1836; to $1,200,000, June, 1839, and to $1,800,000 in 1881.

The leading factor in the establishment of the Hamilton Company was doubtless the success of the Merrimac Company, and the prompt subscription of the capital stock was probably induced by the confidence which the subscribers had in Mr. Samuel Batchelder, owner of a mill in New Ipswich, N. H., who had agreed to become agent of the new corporation, a fact which was duly set forth at the head of the subscription papers. Accordingly, in 1825 Mr. Batchelder gave up the management of his own mill and removed to Lowel to superintend the construction of the first mill; in 1826 the second mill was built, each mill having a capacity of 6,144 spindles. In 1827 Mr. Batchelder adapted the power loom to the production of twills, and during that year the Hamilton Mills produced the first drilling, which has since maintained its place among the standard fabrics, the first lot being sold at the semi-annual sale of the New England Society, August, 1827, at 19¼ cents per yard. This was an entirely new article, and so well did it take, that the treasurer of the company signed a contract for the entire product of the mill on this fabric for six months.

In 1830 a third mill was erected about equal in capacity to the two former buildings. In 1831 Mr. Batchelder resigned, to the regret of the shareholders, owing to friction between himself and the treasurer, Mr. Eben Appleton. He was urged by Mr. Batchelder Jackson and Mr. Nathan Appleton to withdraw his resignation, but feeling that he could not work

in harmony with the leading parties he refused to do so. He was succeeded by Mr. John Avery, who had been a paymaster in the Waltham Mills and agent of Appleton Mills, which latter position he left to assume the superintendency of the Hamilton Mills.

In 1845 the company was operating 22,140 spindles and 608 looms in the three mills, with an output of 110,000 yards of cloth weekly; it employed 650 females and 250 males, and consumed 42,000 pounds of cotton weekly. In 1846 a fourth mill was built, and another in 1847.

During the War of the Rebellion, the Hamilton Mills substituted woolen machinery for a great part of their cotton machinery, and began the manufacture of fine woolen goods, paying an abnormally high price for the raw material. With peace came a declension of "war prices," and the consequent loss to the company resulted in years of struggles and of low dividends.

In 1864 Oliver H. Moulton, who had been overseer in the Pemberton Mills, Lawrence, Mass., and superintendent of the Amoskeag Mills, Manchester, N. H., succeeded Mr. Avery as agent of the Hamilton Mills. In 1865 the Hamilton Company was operating five mills, containing 51,268 spindles and 1,348 looms, employing 850 females and 425 males, and consuming 50,000 pounds of cotton and 10,000 pounds clean wool weekly in producing 235,000 yards of delaines, flannels, prints, tickings, sheetings and shirtings made from yarns Nos. 10 to 53.

In 1881 an addition was built on Mill No. 2; in 1882 a new six-story mill was built, and in 1883 a mill 150 x 50 feet was built, this being four stories high when completed. In July, 1895, a new storehouse was added; and in 1910 the company in its six mills operated 89,024 ring spindles, 29,236 mule spindles, 2,550 looms, power being furnished by ten turbine water wheels and forty-one engines of 2,600 horse-power.

The Hamilton Mills consisted of two departments—the one for manufacture of cotton and woolen cloths, the other for printing of calicoes.

In 1828 a print works was built, and William Spencer came from England to superintend it; he was an expert, and had had charge of print works in Ireland. He held the position for thirty-four years, then was succeeded by William Hunter, who had come from England four years previously to become overseer of the color shop of the Hamilton Print Works. In 1866 William Harley, who came from Scotland and had worked at Southbridge, came to Lowell, where he was superintendent of the Hamilton Print Works for ten years. In 1876 Thomas Walsh, who had been an overseer in the printing room, was advanced to the superintendency of the print works. On June 25, 1910, the print works department of the Hamilton Manufacturing Co. was by sale transferred to the Pacific Mills.

The officers of the Hamilton Mills from their inception have been: *Presidents,* P. T. Jackson, 1825-1831; Geo. W. Lyman, 1831-1833; Wm.

Appleton, 1833-1852; Ignatius Sargent, 1852-1859; Wm. Appleton, 1859-1860; Josiah G. Abbott, 1860-1863; Geo. W. Lyman, 1863, one month; Jno. A. Burnham, 1863, five months; Nathan A. Tufts, 1863-64, six months; Samuel Batchelder, 1864-1870; Hocum Hosford, 1871; James Longley, 1871. *Treasurers,* Wm. Appleton, 1825-1830; Ebenezer Appleton, 1830-1833; Geo. W. Lyman, 1833-1839; Thomas G. Cary, 1839-1859; Wm. B. Bacon, 1859-1861; Arthur T. Lyman, 1861-1863; Arthur L. Devens, 1863-1867; Eben Bacon, 1867-1869; Samuel Batchelder, 1869, three months; Geo. R. Chapman, 1870, six months; Jas. A. Dupee, 1870-1886; James Longley, 1886, one month; Chas B. Amory, 1886-1909; Arthur T. Sharp, 1909. *Agents,* Samuel Batchelder, 1825-1831; John Avery, 1831-1864; O. H. Moulton, 1864-1905; Clarence N. Childs, 1905. *Superintendents of Print Works,* Wm. Spencer, 1828-1862; Wm. Hunter, 1862-1866; Wm. Harley, 1866-1876; Thomas Walsh, 1876-1907; H. S. Duckworth, 1907. *Assistant Treasurers,* Arthur R. Sharp, 1902-1903; Franklin D. Williams, 1903-1909.

The officers of the company in 1910 were: James Longley, president; Arthur R. Sharp, treasurer; C. N. Childs, agent.

Messrs. J. M. Beebe & Co. were selling agents for the Hamilton Manufacturing Co. from 1865-1866, Messrs. Frothingham & Co. from 1866-1873, and Messrs. Joy, Langdon & Co. from 1873-1909. Messrs. Wellington, Sears & Co. then became the distributors.

WHITIN MACHINE WORKS.

Whitin Machine Works, Whitinville, Mass., originated with John C. Whitin in 1830, at the time he was in charge of the machinery repairs of the cotton mill conducted by his father, Col. Paul Whitin; his brother, Paul Whitin, Jr., and himself in partnership. Being dissatisfied with the picker in use, he determined to improve it, and in less than two years had the improved machine at work. He secured a patent in 1832, and the demand for this machine from other manufacturers determined Mr. Whitin to manufacture the "Whitin Improved Picker" for sale. To manufacture the machines he turned the picker room of the old Northbridge Manufacturing Company, 40 x 32 feet, into a workshop, and in this old brick building the business of the Whitin Machine Works began. Machinery and tools were set up in it and put in operation. They were crude as compared with what were later used, yet with the improved devices of Mr. Whitin, pickers or lappers were produced so superior to those previously in use that, from 1834, when the first machine was sold, the demand steadily increased. For many years most of the pickers in use throughout the country were made at these works.

Whitin Machine Works,
Whitinsville, Mass.

JAMES H LAMB Co

The firm was encouraged to build other machinery in the same line, the list gradually increasing, so as to include cards, card-grinders, doublers, railway heads, drawing frames, ring spinning frames, spoolers, warpers, dressers, looms and combers; indeed, all the machinery used in cotton mills, except mules and slashers and finishing machinery. The aim was to improve every machine to the utmost. The spindle was improved by the invention of the "Gravity" spindle. The invention of the Whitin union card, for which Mr. Whitin obtained a patent in 1862, was followed by that of the revolving flat card, and the common loom by the dobby loom. The comber has been so improved as to make its production nearly double that of any other, giving the Whitin Works a practical monopoly of this branch of the business. The Whitin picker, after fifty years of profitable manufacture, was taken from the list and its manufacture discontinued.

To accommodate their rapidly increasing business, the original shop was enlarged and new buildings were erected. In 1847 the firm built the "New Shop," three hundred and six by one hundred and two feet, two stories, and basement on the south side. This was then said to be the largest machine shop in New England. After that date many new buildings and additions to old ones were made, until, in 1910, there were twenty acres of floor space, all connected, and a foundry floor of more than two acres, there being an accommodation for three thousand men in the works. The machine shop was the property of the firm of P. Whitin & Sons until the firm was dissolved in 1864. From 1860 to 1864 John C. Whitin spent much of his time in Holyoke, where he had purchased and was conducting the Holyoke Machine Works, and Charles P. Whitin had charge of the "Whitin Machine Shop." On the dissolution of the firm of P. Whitin & Sons in 1864, John C. Whitin took the manufacturing of machinery, which had grown from the production of one picker a month in the "Old Picker House" to the production of hundreds of thousands of dollars worth of machinery of a large variety every year in the large shop of 1847 and its adjuncts. On coming into his sole proprietorship, Mr. Whitin erected a new shop parallel with the shop of 1847, north of it, four hundred and seventy-five feet, with three stories and a basement.

Mr. Whitin secured patents on the Whitin improved picker in 1833 and on the union card in 1862. These machines proved useful to the manufacturers and profitable to the inventor.. His inventions, however, bore no comparison in intrinsic value to the many improvements he made in tools and implements for working metals, or to the simplifying of existing methods. As long as he continued in the active management of the shop, he took the greatest interest in all improvements in tools. The last machine to which he gave special attention was for drilling spinning-frame rails, completing the two of a set for a spinning-frame at one operation. It was with him a principle never to seek the protection and profit of a

patent for any tool he was to use himself. He felt that the gain in his own work was all the profit he should desire.

In 1870 the business which had been for the six previous years in the sole proprietorship of John C. Whitin was organized into a joint stock corporation under the name of "The Whitin Machine Works;" John C. Whitin, president; Josiah Lasell, treasurer, and Gustavus E. Taft, superintendent. Mr. Lasell was Mr. Whitin's son-in-law, and had been in his employ since 1860. In 1881 Mr. Taft became agent and Harvey Ellis superintendent. On Mr. Whitin's death, April 22, 1882, Mr. Lasell became president and treasurer. On Jan. 1, 1886, Mr. Lasell's son-in-law, G. Marston Whitin, became treasurer. On the death of Mr. Lasell, March 15, 1886, his oldest son, Chester W. Lasell, was made president. On the death of Mr. Taft, June 24, 1888, his oldest son, Cyrus A. Taft, was made agent, and continued in this office several years. On the death of Harvey Ellis in 1891, W. L. Taft, second son of Gustavus E. Taft, succeeded to the superintendent's office. In 1897 he was succeeded by Albert H. Whipple. The officers in 1911 were: Chester W. Lasell, president; G. Marston Whitin, treasurer; Kent Swift, assistant treasurer, and Albert H. Whipple, superintendent. Thus have these machine works, which Mr. Whitin began in 1832 in a room thirty-two by forty feet, grown to a plant with twenty-six acres of floor space, with a foundry of more than three acres of floor. Three thousand skilled mechanics were able, through improvements in tools and machines, to accomplish as much as five thousand could have accomplished in the beginning. Slow plodding oxen at first carried the product to the market. In 1911 cars from all parts of the country came into the freight house located on their own premises, propelled by electricity, *for which purpose the first electric freight motor ever constructed was built.* The first shop used but a portion of the water power at command, but in 1911 the works were using all of that power, much increased by reservoirs, and steam engines of 3,000 horse-power have been added, which run a powerful dynamo, giving electrical power, readily transmitted without shafting to any part of the works. The Providence Machine Company was absorbed by Whitin Machine Works in 1909. (See Volume 2.)

THE IDENTITY OF THE WHITIN FAMILY WITH COTTON MANUFACTURING.

BY REV. JOHN R. THURSTON.

In 1808 Northbridge was smitten with the cotton factory fever, which was then widely spread in the New England States, as Seth Wheaton, of Providence, who initiated the cotton manufacturing at Blackstone, wrote to his brother at Washington, Aug. 20, 1809, "More than fifty mills are now erecting in the New England States for this brand only." This interest in cotton manufacture, which extended as far south as Delaware, is due not only to the invention of machinery for spinning and weaving, and this by "power," but especially to the invention of the cotton gin by Eli

Whitney in 1792, by which "more cotton could be separated in a day from the seed, by the labor of a single hand, than could be done in the usual manner in the space of many months." This reduced the price of cotton so that it could be a rival of wool and flax, which heretofore had almost alone furnished the material for textile fabrics for the people.

In 1809 Col. Paul Whitin erected a cotton mill at the upper dam which was about three hundred feet east of the present dam of the Whitin Machine Works. Col. James Fletcher, the father-in-law of Mr. Whitin, contributed the water power as his share in the enterprise. After the erection of the mill, Mr. Whitin organized a company, of which he was the principal stockholder, for the manufacture of cotton goods, styled "The Northbridge Cotton Manufacturing Company," but the act of incorporation was not obtained until June 9, 1814. From the names of the incorporators, Paul Whitin, James Fletcher, Phinney Earle, Silas Timothy, and Charles and John Sabin and Joel Lackey, it is evident that Mr. Whitin had obtained the co-operation of men from other towns. This was the third cotton mill erected in the Blackstone Valley, above Pawtucket—the mill of Almy Brown and the Slaters preceding it by three years at Slatersville, and the original mill of the Blackstone Co., at Blackstone, preceding it by one year. The manufacture consisted in breaking, carding and spinning. The raw material, having some seeds and much dirt mixed with it, was put out to families to have these removed, as "pickers" had not yet been introduced. Some families took a bale, some half a bale, and some less. For this work four to six cents a pound was paid. After carding and spinning, the yarn was given out to families to be woven by hand, the weavers receiving eight cents per yard for weaving No. 16 yarn, which was the grade made at that time. The weaving was done in this manner for six or eight years, when the power loom was introduced. The original Northbridge Mill was of wood, and had a capacity of 1,500 spindles. Paul Whitin, Jr., then ten years of age, commenced work in this mill on the day of its starting, tending the breaking machine. The mill was operated several years with small returns. It was rented for two years to Gladding and Cady, and was sold in 1824 to William & Thomas Buffom. It was bought in 1829 by Samuel Shove, who operated it until 1831.

In 1815 Colonel Whitin, not content with what he was doing in the Northbridge Cotton Manufacturing Company, entered into partnership with Colonel James Fletcher and his two sons, under the firm name of "Whitin and Fletcher," and they fitted up "The Old Forge" building on the south side of the river, a few hundred feet below the mill of the "Northbridge Co.," for a cotton mill of 300 spindle capacity for the manufacture of yarns. This mill was operated under this partnership until 1828, when Mr. Whitin, who owned a one-half interest, purchased the other half of the Fletchers' and formed a new partnership with his sons, Paul, Jr., and John C., under the name of P. Whitin & Sons, for the manufacture of cotton goods.

Paul Whitin, Jr., was at this time twenty-seven years of age. His previous training had been mercantile, and in the business of the new firm he took charge of the mercantile and financial department. John C. Whitin, then nineteen years old, had had his training in the mill and in the machine room of the Northbridge Cotton Manufacturing Co., and was thus prepared for his department of the new firm, the management of the manufacturing and mechanical departments. Mr. Paul Whitin, Sr., merely invested capital and had no personal care or responsibility in the management of the business.

The company erected on the site of the "Old Forge" mill a new building of brick, thirty-two by sixty feet, two stories, with attic room and basement, equipped with 1,500 spindles, this mill being used for its original purpose until 1845.

Soon after the erection of this mill by P. Whitin & Sons, cotton manufacture was begun in another part of the town. As early as June 14, 1814, "The Northbridge Cloth Manufacturing Co.," for the manufacture of cotton and woolen cloth, had obtained an act of incorporation, the incorporators being Levi Lincoln, Antipas and Jesse Eddy, Amasa Roberts, Timothy Earle, David Waldo, Wm. Hendricks and Silas Earle, most of whom did not reside in the town. Their mill was erected at the water privilege in what is now known as Riverdale, on the Blackstone River. The mills built prior to that being on the Mumford River, a branch of the Blackstone, in what is now Whitinsville. But cotton cloth was not made until 1831, when the property came under the control of Sylvanus Holbrook. In 1830 he erected a mill on the east side of the river and fitted it with cotton machinery, and began to make sheetings. In 1832 Mr. Holbrook built at the "Upper Village," on the "Blackstone," now "Rockdale," "The Cotton Mill," north of the old woolen mill, and began the manufacture of sheetings and drillings, and in 1836 one-third of the looms were put upon print cloths. In 1837, having discontinued the manufacture of satinets, Mr. Holbrook put cotton machinery into the "Woolen Mill" and made Kentucky jeans, until the mill was burned in 1839 or 1840. He then rebuilt it, filled it with cotton machinery and manufactured cotton goods. In 1846 the North or "Cotton Mill," the first to be built in Rockdale, was burned. Mr. Holbrook repaired the walls and floors, but never installed the machinery. In 1851 fire destroyed all the factory buildings but this, as well as a large number of dwellings. This closed all manufacturing in this village until 1856, when the property was bought by the firm of P. Whitin & Sons.

We now return to Whitinsville. In 1831, Col. Paul Whitin having died, the firm was reorganized, Mrs. Paul Whitin, Sr., and her sons, Paul, John C. and Charles P. being the partners. Charles P. Whitin had been employed in the office of the old firm, and had attained his majority the previous year. In the new firm Mr. Paul Whitin retained the mercantile

and financial departments, Mr. Charles P. Whitin took charge of the cotton manufacturing, and Mr. John C. Whitin took charge of the new department, the building of cotton machinery. The old Northbridge Cotton Manufacturing Company's Mill was bought by the firm and put into operation, and so continued until 1861. In 1845 the "Stone Mill" was built, with a capacity of 7,500 spindles.

In 1847 Mr. James F. Whitin, the youngest son of Col. Paul Whitin, who for many years had had charge of the books of the concern, was admitted to the firm.

In 1849 the Whitins bought up the capital stock of the "Uxbridge Cotton Mill" of 10,000 spindle capacity in North Uxbridge, which they operated until the firm was dissolved in 1864. In 1856, having purchased the property in Rockdale, used by Mr. Holbrook and others for manufacturing cotton goods, they built the new Rockdale Mill, with a capacity of 10,000 spindles. About 1857 they bought the stone cotton mill in East Douglas, of about 8,000 spindle capacity, and operated it until the war.

In 1864 the firm of P. Whitin & Sons, manufacturers of cotton goods and cotton machinery, which had been founded in 1826, was dissolved, and the business was divided. The cotton manufacturing which had increased from 1,500 spindles to 36,500 was divided, Mr. Paul Whitin taking the mill at Rockdale and the mill property at Riverdale, which P. Whitin & Sons had purchased the year before; Mr. Charles P. Whitin, the mills in Whitinsville and in East Douglas; Mr. James F. Whitin, the mill in Uxbridge, and Mr. John C. Whitin, the manufacturing of cotton machinery.

At this time the Paul Whitin Manufacturing Co. was formed, with Mr. Paul Whitin as president and his son, Charles E. Whitin, as agent. To the Rockdale Mill this company soon added the mill at Riverdale, putting an addition to the stone building which had been occupied by Mr. Harvey Waters for the manufacture of scythes and bayonets, and filling it with cotton machinery, making it a mill of 7,000 spindles. They operated this mill until it was burned in 1889.

In 1884, on the death of Mr. Paul Whitin, Mr. Charles E. Whitin became treasurer. His eldest son, Mr. Henry T. Whitin, had become superintendent in 1870. When the mill in Riverdale was burned, the company did not rebuild it, but concentrated all their business at Rockdale, making an addition to their mill built in 1850 of more than 12,000 spindles; another addition was made in 1893, and another in 1895-6, and then the mill had 55,000 spindles and 1,500 looms, many of which are of the Jacquard pattern. The product of the mill is fine fancy weaving from Cong Staple cotton and silk from thread from No. 40 to No. 120.

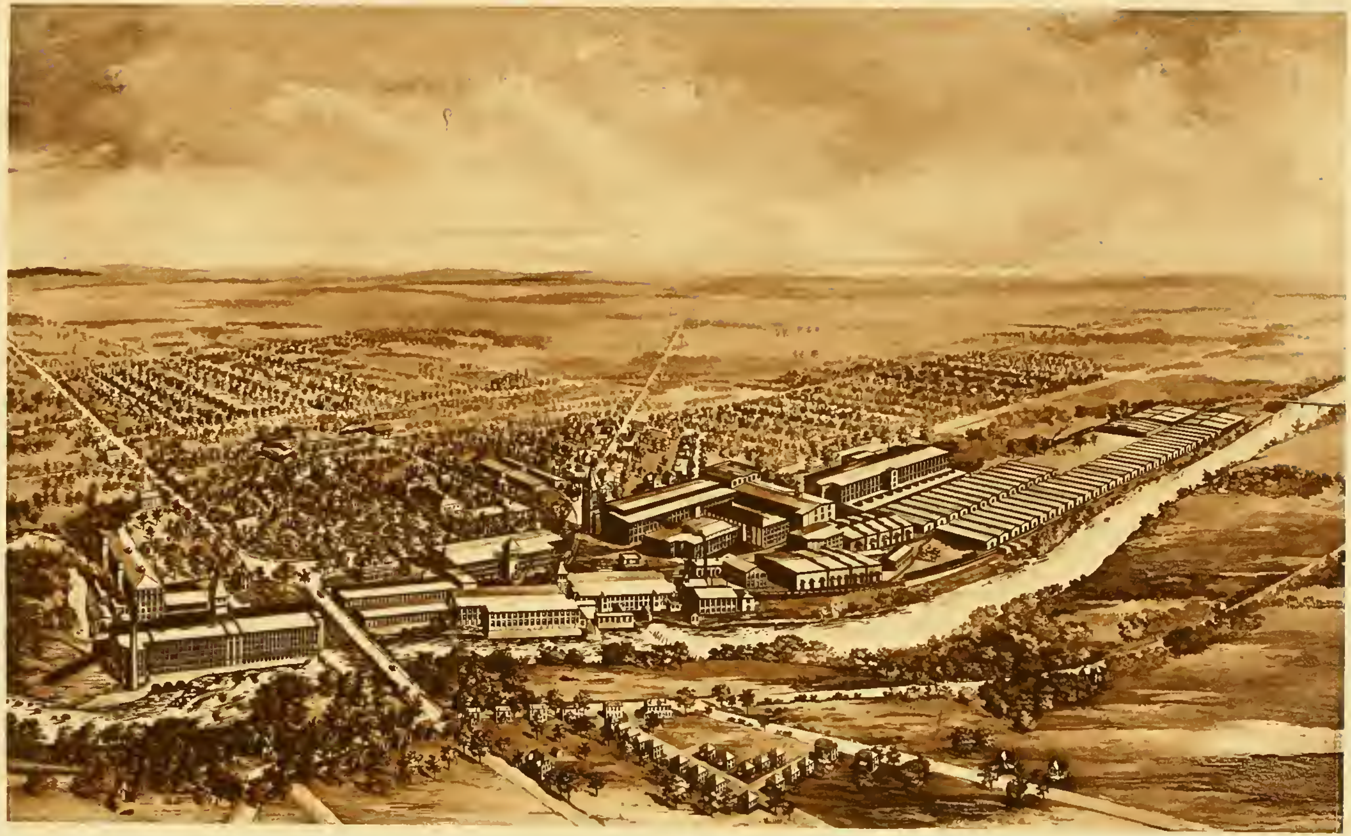
Mr. Charles P. Whitin enlarged the stone mill at Whitinsville, making its capacity 13,300 spindles. In 1866 he united his two elder sons, Edward and William H., with him in the business, under the name of The Whitinsville Cotton Mills. The same year he, with his brother, Mr. James F.

Whitin, built the mill at Linwood of 15,000-spindle capacity under the firm name of Whitin Brothers.

In 1881 Mr. Whitin purchased the mill property at Saundersville and renovated it by putting in new machinery. The capacity is 13,600 spindles. This same year his youngest son, Arthur F., was taken into the firm. In 1887 Mr. Charles P. Whitin died. After his death the business was continued by his three sons. Since the death of William H., in 1893, the surviving sons, Edward and Arthur F., have conducted the business. In 1895 they, with their uncle, James F. Whitin, enlarged the Linwood Mill, making its capacity 26,500 spindles. After the death of Mr. James F. Whitin, Mr. Edward and his brother Arthur F. bought the interest of his son, Albert H., in the Linwood Mill and the one-quarter interest of his grandson Frederick. The products of the Whitinsville and Linwood and Saundersville Mills are fine cambrics, sateens and shirtings.

Mr. James F. Whitin, on the dissolution of the firm of P. Whitin & Sons, took the mill at North Uxbridge. The next year, with his brother, Charles P., he built the mill at Linwood under the firm name of Whitin Brothers, and enlarged it in 1895. In 1900 he enlarged the North Uxbridge Mill, making its capacity 17,000 spindles. After his death in 1902 this mill came into the possession of his grandsons, Frederick B. and James E. Whitin, the latter, James E. Whitin, becoming sole owner and president. The product is fine sheetings and shirtings.

This family has been continually engaged in the coctton industry for ninety-eight years. Colonel Paul Whitin began in 1809 with several others in a mill of 1,500 spindles. But this mill never had success until it came into his sole possession and control. The family now own and control five mills, with an aggregate of nearly 125,000 spindles. Three of these are in the town in which they began this work; two are in adjacent towns. Early in their history they engaged in the manufacture of cotton machinery. This continued in one branch of the family, and is employing nearly 2,000 hands, is now one of the largest cotton machinery manufacturing concerns in the country, and is enlarging its plant very greatly. Some facts may account for this steady growth and success. They have given their personal attention and best energies to their business. They have always paid those whom they employed promptly. They have invested in their business only their own capital, preferring to let enlargement of plant wait until they could make it with their own rather than to use the capital of other parties. They have always resided where their business has been carried on, which has enabled them to give their own supervision to it, and they have always taken interest and pride in the welfare of the community, as is seen by the excellent public buildings, good roads, good schools and a good library free to all, while their employees have always been treated with the utmost consideration and generosity, many of them remaining in the Whitin employ for thirty or forty years.



Ludlow Manuf. Associates

JAMES H LAMB CO.

From 1826 to 1884 the various interests of the Whitin family were conducted under the name of P. Whitin & Sons, and the manufacture of cotton machinery became an important part of the business of the firm. This has been retained by one branch of the family, and under the name of the Whitin Machine Works has become one of the largest manufacturers of cotton machinery in the country. Thus for ninety-six years has this family been identified with the cotton industry.

THE LUDLOW MANUFACTURING ASSOCIATES.

The jute and hemp works of the Ludlow Manufacturing Associates at Ludlow, Mass., were originally started at Braintree, Mass., in 1848, by Charles T. Hubbard, then junior partner in the old firm of Sewall, Day & Co. In 1852 a company was incorporated with the following list of shareholders: Benjamin Sewall, 111 shares; Moses Day, 111 shares; Moses Sewall, 74 shares; Charles T. Hubbard, 74 shares; M. D. Ross, 50 shares; Dean Randall, 50 shares; David S. Roberts, 30 shares.

From 1848 until his death, in 1887, Mr. Charles T. Hubbard was the treasurer and managing head of the business. In 1865 Cranmore N. Wallace, returning from four years' service in the Union Army, entered the mill as office clerk; in 1884 he became the selling agent, and later was made president of the company. In 1868 Mr. Hubbard, acting for various creditors of the Ludlow Mills Company, bought the property in Ludlow, Springfield and Wilbraham, Mass., where the present (1911) mills are located. The business was reorganized under the name of the Ludlow Manufacturing Company, Mr. Hubbard being chosen as treasurer, while Mr. Lemuel H. Brigham, agent, under the old management, was retained in his former position.

The property consisted of some old stone mills, dating back to about 1830; also a small one and a half story wooden cotton mill, and a small machine shop. This cotton mill was operated for the production of seamless cotton bags until its destruction by fire a few years later.

The Boston Flax Mills in Braintree, Mass., had, in 1878, grown by small additions into a conglomeration of small detached mills with old-fashioned and inadequate power equipment, and it was seen that the mills must be rebuilt entirely or the business be moved to another location. Mr. Hubbard then arranged to sell the good will and machinery of the Flax Mills to the Ludlow Manufacturing Company. For the reception of this machinery the Ludlow Company built a new mill and dug a canal to operate its wheel. In 1881 Mr. John E. Stevens was appointed superintendent in charge of the manufacturing. He had served an apprenticeship in the shops

of Peter Fairbairn (now Fairbairn-Macpherson), of Leeds, England. He then acted as superintendent of a flax mill in Russia, but later returned to the Fairbairns, and at the time of his coming to Ludlow was their continental selling agent, located in Dresden, Saxony. In 1837 Charles T. Hubbard, the founder of the business and its treasurer, died, and was succeeded by his son, Charles W. Hubbard, a graduate of Harvard, Class of '78, and in the same year Mr. L. H. Brigham, the agent, resigned, and was succeeded by Mr. Stevens. From 1887 until the death of Mr. Stevens, in 1905, the managing officers of the company were: Charles W. Hubbard, treasurer; Cranmore N. Wallace, selling agent; John E. Stevens, manufacturing agent. After the death of Mr. Stevens he was succeeded by his son, Mr. Sidney Stevens, a graduate of the Harvard Scientific School, Class of 1900, who had served for four years as his father's assistant in the mills.

Of the original property purchased in 1868 only the church and a few tenement houses remain. The plant extends (1911) almost a mile along the banks of the Chicopee River, with a total fall of ninety-two feet, developing about ten thousand horse-power, the larger part of it with electric drive; there are seventeen acres of floor space, twelve acres of warehouse floors, ten miles of water mains and eight miles of tracks operated by four locomotives.

The mills manufactured jute bagging for covering cotton, jute and hemp carpet yarns, twines and marlines, upholsterers' webbing, binder, twine and cordage, and also machinery for its own mills. The productive capacity of the mills was one hundred million pounds yearly. The capital was four million dollars. Because of the limited powers formerly granted by the incorporation laws of Massachusetts, it was found desirable to organize the business under the form of a trust agreement, by which the conduct of the business was placed in the hands of nine trustees, under the title of the Ludlow Manufacturing Associates.

The management in 1911 occupied an office at 55 Congress Street, Boston, and did its own selling. Cranmore N. Wallace was the president and selling agent; Charles W. Hubbard, treasurer and secretary, and Sidney Stevens, manufacturing agent.

The history of the Ludlow Associates would be incomplete without a reference to the improvements wrought by them in Ludlow. The village, at the time they purchased the mills there, consisted of two country roads, with a few very old tenement houses, a single-room schoolhouse and a church owned by the company. The nearest railway was the Boston and Albany, a mile away; later on the Springfield and Athol was built through the village and a spur track was laid to the mill yard.

About 1878 new streets were laid out and constructed by the company, a number of new cottages were built by them, and a six-room schoolhouse to accommodate the increasing number of scholars. The company has since built all the sewers and supplied the village with water and electricity.

Dana Warp Mills.

JAMES H. LAMB Co

From this small beginning a beautiful town has sprung up, with six or seven miles of good streets macadamized, and with concrete gutters and concrete curbing to the sidewalks. The company at this writing (1911) owns 558 cottages and tenements, most of which contain from five to seven rooms and rent for from six to twelve dollars a month, nearly all being fitted with baths. A model boarding house for girls is maintained by the company, and a hospital building has also been provided. The town possesses a handsome library known as the Hubbard Memorial Library, which was erected as a memorial by the widow and children of the late Charles T. Hubbard. The social life and amusements of the village have their home in the beautiful building known as the Stevens Memorial Hall, built by the Ludlow Manufacturing Associates in 1905-6, as a tribute to the memory of Mr. John E. Stevens, by whom the institution of this clubhouse had been planned, though on simpler lines. The building in 1911 was in charge of the Ludlow Athletic and Recreation Association, which at that time had over 800 members, was self-supporting and was managed by a board of directors, including both men and women. There is an entrance at each end of the building, one being for the men and the other for the girls. The basement of the Stevens Memorial Hall is divided into a large bowling room, a swimming tank with shower, and tub baths, a men's locker room at one side and a girls' on the other. The tank was used on alternate days by the two sexes, the girls and boys enjoying all the privileges and capable instructors being employed to teach them to swim.

On the first floor is the girls' parlor, with appropriate furnishings; including a piano. Next comes the men's recreation room with six pool tables, bought and paid for by the association. Then comes the reading and smoking room, where current magazines and technical papers are on file. Up another flight of stairs is the main hall, with stage and gallery. This hall is used for a gymnasium, for dancing parties and for dramatic and other entertainments. In addition, the building contains six club or class rooms, where instruction is given in cooking, dressmaking and millinery.

DANA WARP MILLS.

Dana Warp Mills are located in Westbrook, Maine. The mills take their name from Woodbury Kidder Dana, a sketch of whose life appears in this volume. In the year 1866 Mr. Dana formed a partnership with Thomas McEwan, and, as Dana & McEwan, they began the manufacture of cotton warps at Saccarappa Falls, on the Presumpscot River, in the town of Westbrook, Maine.

After Mr. McEwan's early withdrawal, and except for three years,

when in partnership with his brother, Frank J. Dana, as W. K. Dana & Co., Mr. Dana continued in the business alone until 1892, when the present corporation was organized under the name of Dana Warp Mills, its capital stock in 1911 being $130,000 and its officers as follows: President, Lyman M. Cousens; treasurer and general manager, Woodbury K. Dana; superintendent, Philip Dana; assistant superintendent, Luther Dana; directors, Lyman M. Cousens, Woodbury K. Dana, Philip Dana.

From 720 spindles, in 1866, the mill grew to a thoroughly equipped plant of 40,000 ring spindles, 1,200 twister spindles and 40 looms for seamless grain bags, about 550 bales of cotton being used monthly and about 400 hands employed. The mill is modern in every respect, in equipment, heating, lighting and in conveniences for employees. It has its own model dyehouse, is equipped with combers, and spins from eight to eighty.

In 1900 the corporation purchased the large and well-planned Gingham Mill, then lying idle. This has been filled with up-to-date machinery, additions have been made to the building, and to-day the various buildings of Dana Warp Mills constitute a model plant, as is shown in the accompanying full-page illustration.

Dana warps have been favorably known to the trade for forty years. Men who, out of friendship, perhaps, began to patronize the maker of these warps in the sixties, are to-day his best customers, simply because experience has shown them that the product shipped them is always standard, its color fast, its count correct and its supply certain. To keep a customer satisfied for half a century is no mean test of the value of goods supplied him. Mr. Dana does not believe in obsolete machines or methods; everything must be strictly up-to-date. The quality of his product is due to the use of the best-known appliances, skilled labor and intelligent supervision. Mr. Lyman M. Cousens, the president of the corporation, is also its selling agent, and to his business-like methods, his deserved reputation for fair dealing, and his tireless energy much credit must be given.

THE BOOTT MILLS.

The Boott Cotton Mills, so named in honor of Kirk Boott, were incorporated at Lowell, Mass., March 27, 1835, by John A. Lowell, Abbott Lawrence and Nathan Lawrence, with a capital of $1,000,000, which was increased in 1837 to $1,200,000, divided into 1,200 shares, with a par value of $1,000. This capital up to 1911 had not been increased.

The construction of the first four mills of the company was begun

in 1835, the buildings being erected on the property secured for cotton mill sites by Lawrence, Lowell, Jackson, Appleton, Boott and their associates. These four mills and a large boarding house were completed in 1836, and began operations with Benjamin F. French as the first agent. In 1845 the company operated in its four mills 32,036 spindles, 910 looms, used 63,000 pounds of cotton weekly in the production of 185,000 yards of cloth, and it employed 780 female and 130 male operatives. Linus Child was the second agent, and, in 1862, the stock having depreciated forty per cent through the conservative management, no improvements having been made since the mills were built, Mr. William A. Burke was transferred from the Lowell Machine Shop to the Boott Cotton Mills, to take the place of Mr. Child as agent, who at once inaugurated an extensive reconstruction, operations in the mills being suspended for periods of two and three months in 1861, 1862 and 1863, to allow of rebuilding.

A new mill was built, and in 1865 the company operated 71,324 spindles, 1,878 looms, consuming 100,000 pounds of cotton weekly in the production of 350,000 yards of drillings, sheetings, shirtings and print cloths, and it employed 1,020 females and 290 males. At that time the Boott Cotton Mills spun Nos. 14 to 40 yarns.

The first building of the Boott Cotton Mills was 261x60 feet, five stories high, and six others of a similar character were eventually added, the seven mills being built around a quadrangular park for the purpose of obtaining good light, and of adding to the comfort of the operatives, the completed plant covering an area of nine acres, part of which is in Centralville. This plant was, with the exception of the Massachusetts Mills, the last of the great system of cotton mills of Lowell incorporated by the Proprietors of Locks and Canals Company. The buildings were equipped with the latest improved machinery, and the company operated 148,412 spindles, 4,002 looms, and in 1903 produced 800,000 yards of sheetings, shirtings and printing cloths per week, employing 1,500 females and 478 males, consuming 250,000 pounds of cotton per week. From 1901 this company made a large amount of linen goods, consisting principally of towels and handkerchiefs.

The officers were: Treasurers, John A. Lowell, 1835-48; J. Pickering Putnam, 1848-58; T. Jefferson Coolidge, 1858-65; Richard D. Rogers, 1865-75; Augustus Lowell, 1875-86; Eliot C. Clarke, 1886-1904; A. S. Covel, 1904-5; Frederick A. Flather, 1905. Agents, Benjamin F. French, 1836-45; Linus Child, 1845-62; William A. Burke, 1862-68; Alexander C. Cumnock, 1868-95; Victor I. Cumnock, 1895-96; A. C. Thomas, 1896-1908; John H. Whitten, 1908-10; E. W. Thomas, 1910.

The officers of the corporation in 1905 were: Arthur T. Lyman, president; A. S. Covel, treasurer; F. C. Young, clerk; directors, Arthur T. Lyman, A. S. Covel, C. F. Young, Jacob Rogers, Charles F. Ayer, Charles Lowell, Charles F. Adams, 2d, and Arthur Lyman.

In 1905 the affairs of the Boott Cotton Mills were put into liquidation, when, to save the industry to the city of Lowell, the mills only were purchased by the Lowell stockholders, and a new company was incorporated February, 1905, under the title of the Boott Mills, with a capital stock of $600,000, which was increased to $1,000,000 July 1, 1907, to allow expenditure for improvements. The number of mills in 1910 were ten, these being operated by water, steam and electricity. The capacity of the Boott Cotton Mills in 1909 was 3,500 looms and 160,000 spindles, the number of spindles in operation at the time of liquidation being 135,000.

The company manufactures coarse, medium and fine gray goods. The officers of the Boott Mills in 1911 were as follows: Frank E. Dunbar, president; Frederick A. Flather, treasurer; Edward W. Thomas, agent; directors, Charles F. Ayer, Albert F. Bemis, Frank A. Day, Frank E. Dunbar, Frederick A. Flather, Amasa Pratt, William H. Wellington; selling agents, Wellington, Sears & Co.

THE PACIFIC MILLS.

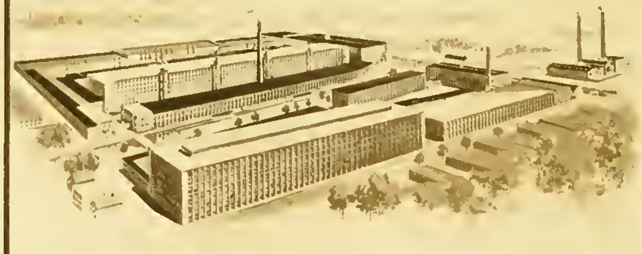
Coincident with the laying out by the Lawrences and others in 1850 of the City of Lawrence, Essex County, Massachusetts, on the banks of the Merrimac, plans for the Pacific Mills were prepared. The chief promoters of the enterprise were Abbot Lawrence, William Lawrence, Samuel Lawrence, John A. Lowell, Francis C. Lowell, Nathan Appleton, Patrick T. Jackson and other merchants of Boston and Lowell.

The Pacific Mills were incorporated in 1853 with a capital of $1,000,000, which was increased in 1855, 1858, 1862 and 1900, to its present amount (1910), $3,000,000, consisting of 3,000 shares of $1,000 each.

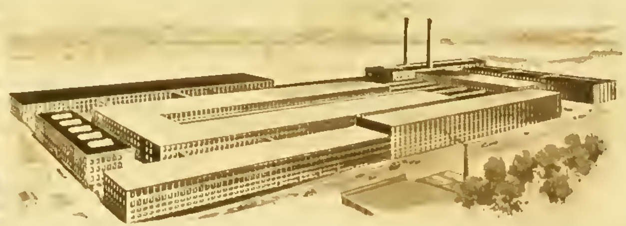
The original mills and print works were built by the Essex Company, under the direction of Captain Charles H. Bigelow, and in 1882 it was found necessary to remodel them in order to bring them up to a standard where they could maintain their leading place against the competition of the best modern mills. Since then they have been enlarged and added to from time to time until they have become one of the largest textile mill plants in the United States. When the additions now in progress are completed, the floor area in the Lawrence plant alone will exceed one hundred acres.

The purpose of the organization was to produce "ladies' dress goods from wool wholly, from cotton wholly, and from wool and cotton combined." The establishment was to include an aggregation of cotton mills, woolen mills and print works.

Their products first appeared in the market in 1854. At that time,



PACIFIC MILLS, LAWRENCE, MASS.
UPPER MILLS.



PACIFIC MILLS,
LAWRENCE, MASS.
NEW PRINT WORKS.

PACIFIC MILLS, LAWRENCE, MASS.
LOWER MILLS.

PACIFIC MILLS, DOVER, N.H.
COCHECO DEPARTMENT.

JAMES H LAMB Co

under a low tariff, English-printed calicoes and printed delaines were largely in competition with home products, and the contest for supremacy was sharp, and in the end a victory for the New England factories.

Through the panic of 1857 and the difficulties of war times the company has passed unscathed, though at times hard pressed, while many of the largest and strongest mills and merchants were crippled.

The Pacific fabrics have won popularity through their excellence as to style, quality and durability, and probably no mill is so well known throughout the country at large as the Pacific Mills. Its chief cotton products are mousselines, chambrays, lawns, organdies, challies, draperies, satines and crepes. The worsted products are poplins, alpacas, cashmeres, henriettas, serges, brocades and diagonals. The product of the mills in 1861 was about 11,000,000 yards; in 1865, 45,000,000 yards; in 1906, 100,000,000 yards, and in 1910 about 150,000,000 yards.

There were no purchases of property of great moment between 1864, when the lower mill property was obtained, and 1909, when the Pacific Mills bought the Cocheco Manufacturing Company, of Dover, New Hampshire. With the purchase of these mills the Pacific Mills made their first large expansion by other means than steady growth. These mills were formidable competitors and they sold through the same selling house. They were among the earlier cotton mills, their various organizations all antedating that of the Pacific Mills.

The Dover Cotton Factory was incorporated in 1812 with a capital of $50,000. This was increased in 1821 to $500,000, and again in 1823 to $1,000,000, and the name was then changed to the Dover Manufacturing Company. Their first mill was built in 1815 and was a wooden structure. Neither of these companies was successful, and a new company, the Cocheco Manufacturing Company, was incorporated in 1827 with a capitalization of $1,000,000, which purchased all the works and property of the Dover Manufacturing Company.

The manufacturing of cloth began under John Williams, the first agent, and the first calico printing in these works was executed prior to 1880 under the supervision of Dr. A. L. Porter.

At the time the Pacific Mills purchased the Cocheco Manufacturing Company, January, 1909, Hamilton de Forest Lockwood was the treasurer, Herbert W. Owen superintendent of the cotton mills, and R. A. S. Reoch superintendent of the print works, all of whom have remained with the Pacific Mills, Mr. Lockwood becoming assistant treasurer.

Previous to the consolidation of these two properties, the Cocheco Manufacturing Company had effected many improvements, and since then the Pacific Mills have erected several new buildings and added extensively to the machinery.

Soon after this purchase it was determined to unite the two large print works, neither of very modern construction, and with this in mind a

tract of land of about seventeen acres was purchased in South Lawrence. On this is now being constructed (1911) a print works more than large enough to handle the work of the two plants in Lawrence and Dover. It will probably be the largest print works in America, if not in the world.

In 1911 the printing business of the Hamilton Manufacturing Company, of Lowell, was purchased, and that is now being combined with the two other print works and will eventually go with the others to South Lawrence.

There is also under construction a six-story worsted yarn mill and a one-story weave-shed to accommodate more than 1,000 worsted looms, covering in all about four acres. The equipment of the mills, including the machinery now arranged for, is as follows:

At Lawrence: 184,352 cotton spinning spindles, 90,476 worsted spinning spindles, 3,945 cotton looms, 3,419 worsted looms, 84 worsted cards, 85 worsted combs, 24 printing machines, and there are about 6,900 operatives employed. At Dover there are 129,248 cotton spinning spindles, 3,104 cotton looms, 16 printing machines and about 2,000 operatives employed. The payroll of the combined mills is about $3,250,000 per year.

Among those who have so largely contributed to the success of the Pacific Mills in the past are: *Presidents*—Hon. Abbot Lawrence, 1853-56; George W. Lyman, 1856-70; John Amory Lowell, 1870-77; Abbot Lawrence, 1877-98; J. Huntington Lowell, 1870-77; Augustus Lowell, six months in 1892, 1893-1900; Arthur T. Lyman, 1900. *Treasurers*—Jeremiah S. Young, 1853-57; George H. Kuhn, six months, 1855; J. Wiley Edmands, 1855-77; James L. Little, 1877-80; Henry Saltonstall, 1880-84; George S. Silsbee, 1894-1907; Edwin Farnham Greene, 1907. *Clerks*—A. H. Clapp, 1853-54; Henry Davenport, 1854-90; Edward J. Payne, 1890-1910. *Selling Houses*—Little, Alden & Co., James L. Little & Co., Lawrence & Co. *Agents*—William C. Chapin, 1853-71; John Fallon, 1871-81, acting; Samuel Barlow, 1881-1902, of print works; Walter E. Parker, 1881, of mills and print works. *Superintendents Cotton*—Joseph D. Burt, A. R. Field, A. M. Wade, Francis H. Silsbee, William H. McDavitt, Irving Southworth. *Superintendents Printing*—John Fallon, Samuel Barlow, Richard Barlow, Harry Wylde. *Superintendents Lower Mill*—Joseph Walworth, Joseph Stone, Charles T. Main, George Owen, J. T. Lord.

UXBRIDGE COTTON MILLS.

Uxbridge Cotton Mills are situated at North Uxbridge, Worcester County, Massachusetts, on the Mumford branch of the Blackstone River. The original business was established in 1810 by Benjamin Clapp, who built a wooden mill there, known as "the Clapp Mill." He was associated with a Mr. Forbes, and in 1815 they sold out to Mellen & Harvey, who manufactured cotton thread there for a short time, when the plant and business passed into the hands of Robert Rogerson, a Boston merchant, who carried it on until about 1825, when he removed the ancient wooden building and built in its place a substantial stone factory, and in 1827 erected near it a second mill, these buildings and machinery costing $250,000; known as the "Crown" and "Eagle" Mills, operated by R. Rogerson, in partnership with Oliver Eldridge under the firm name of R. Rogerson & Co. In 1830 the business was incorporated as "the Proprietors of the Crown and Eagle Mills," Mr. Eldridge having retired and been replaced by Handel Rogerson, who became resident agent of the mills. Mr. Rogerson was compelled, by the financial crisis of 1837, to yield the property to his creditors, who organized a new corporation, Dec. 16, 1840, under the name of the Uxbridge Cotton Mills, with a capital stock of $100,000, which was later increased to $125,000, Charles W. Cartwright, Henry Hall, James Read, George Morey, Daniel Denny, Benjamin Humphrey and Benjamin F. White owning the entire stock. At the first annual meeting, held in 1840, the board of directors chosen were: C. W. Cartwright, Henry Hall, James Read, Daniel Denny. C. W. Cartwright was elected president and treasurer and Samuel Hunt clerk.

The business of the Uxbridge Cotton Mills was conducted by the agents of these owners until 1849, when the property was sold to Paul Whitin & Sons, of Whitinsville, who used the charter and name of the Uxbridge Cotton Mills corporation, and at the meeting held May 9, 1849, a board of directors was chosen including Paul Whitin, John C. Whitin, James Fletcher Whitin and Charles P. Whitin. John C. Whitin was elected president; Paul Whitin, treasurer; James F. Whitin, clerk, and Charles E. Whitin, superintendent.

In 1851 the Whitins increased the capacity of the mills nearly one-half by the erection of a brick building, 120 feet long and of uniform width and height with the two granite mills uniting them by spanning the river with an arch, making the mills, with the intervening structure, 320 feet long. These mills in 1910 were equipped with 17,000 ring spindles, 426 looms, 25 cards, employed in manufacturing sheetings and shirtings, Collins & Co., of New York, being the selling agents. The power was supplied by water, supplemented by a Corliss cross-compound steam engine.

James E. Whitin, president, treasurer and agent. Collins & Co., New York, selling agents.

THE SLATER MILLS.

The Slater Mills are situated at Webster, Mass., and comprise the H. N. Slater Manufacturing Company, at the north village, employed in the manufacture of cotton dress goods, checks, lawns, silesias, jaconets, etc., incorporated 1836; the H. N. Slater Manufacturing Company, at the east village, manufacturing broadcloths, flannels, tricots and doeskins, incorporated 1886; the cotton and woolen factory are situated on French River, and the finishing factory on the outlet from Chaubunnagunganug Pond. (For sketch of first Slater Mill see illustration, *Ibid.*)

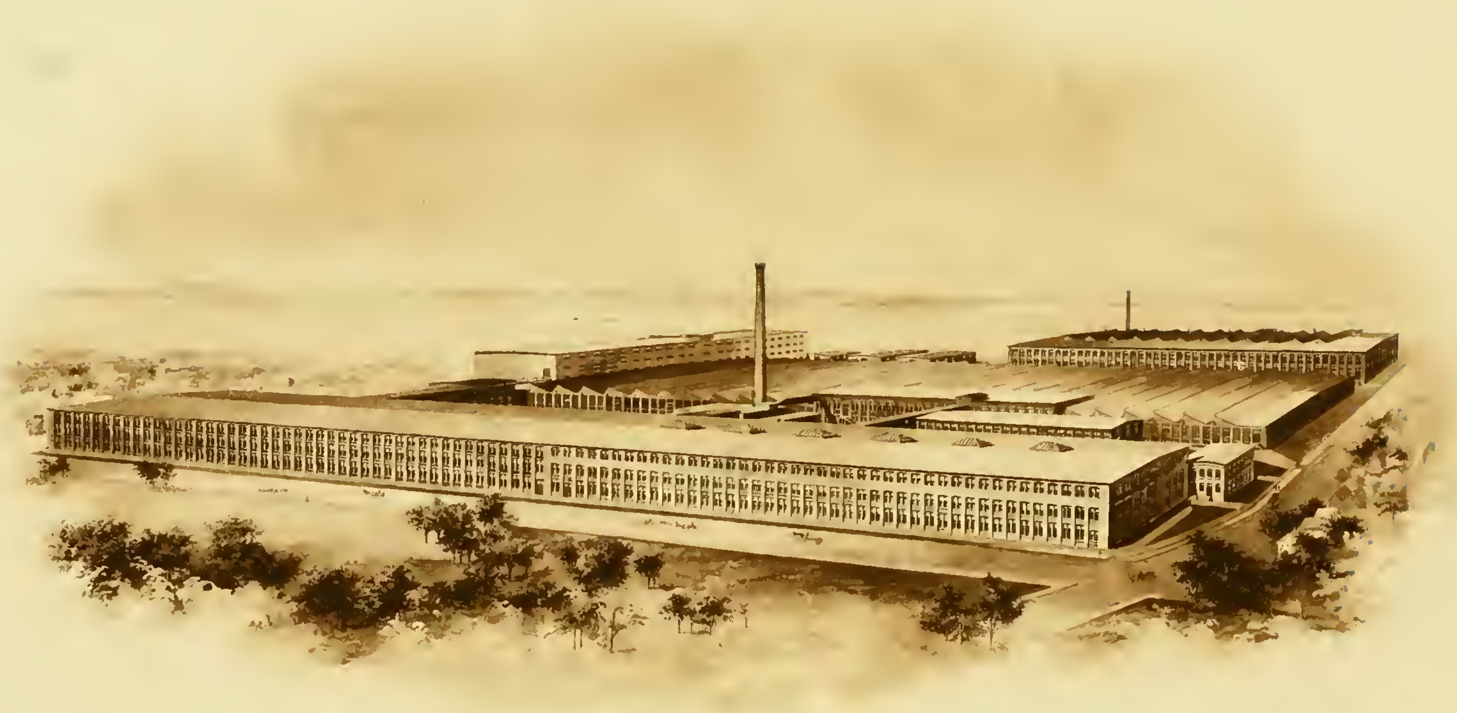
The town of Webster owes its origin, as well as its fame as a manufacturing centre, to the purchase by Samuel Slater and Bela Tiffany, his clerk, in 1811, of thirteen or fourteen acres of land, partly swamp, on which was an unfinished dwelling house, a grist mill, a good sawmill, and a trip-hammer shop situated in an almost deserted region four miles from Oxford, three miles from Dudley and six and a half miles from Thompson, Conn. For this property they paid four thousand dollars. This purchase was followed by others during 1812, including a farm of two hundred and twenty acres with buildings, nine acres bought of Elijah Pratt and 260 more acres from various persons. Five-sixths of this property was owned by Mr. Slater.

Mills were at once built, and in 1813 Slater and Tiffany began in what is now the town of Webster, the manufacture of cotton yarn. At the same time a dye and bleaching house was established and placed under the management of John Tyson, who had an interest in the business. Mr. Tyson died in 1821, and his interest passed into the hands of Mr. Slater.

Further purchases of land were made by Slater & Tiffany in 1814-15, but on the 27th of November, 1816, during the depression in manufactures which followed the war of 1812, Mr. Tiffany sold his interest to Mr. Slater for $8,400. During the war the company began the manufacture of broadcloth under the superintendence of Edward Howard, a Yorkshire man, who had followed the woolen business at home.

Up to 1821 Mr. Slater's business had been conducted solely on a stream which runs from the pond before mentioned, but in that year, through Mr. Howard, a location was obtained on French River, where property was bought at a cost of twelve thousand dollars. In 1822 Mr. Howard transferred one-half the interest to Mr. Slater for six thousand dollars, and in that year, while the woolen mill was building, the old woolen mill was burned. Additional purchases of land were made by Slater & Howard between 1822 and 1824, including about 425 acres, and still other purchases were made at later dates.

On the 2d day of January, 1829, Samuel Slater and his sons, George B. and Horatio Nelson Slater, bought Mr. Howard's interest and, as Samuel Slater & Sons, became the sole owners of all the property which



Dartmouth Manufacturing Corporation,
New Bedford, Mass

JAMES H LAMB Co.

had been purchased since 1811, including the water power of Chaubunnagungamog Pond, and all the water power of the French River included in what is now Webster. During the year following the purchase of the entire property the firm of Slater & Sons became involved in embarrassments, from which they were soon thoroughly extricated, and the business has since been conducted on an ever-growing and prosperous footing.

Mr. Samuel Slater died in 1835, and the business was carried on by George B. and Horatio Nelson Slater until the death of the former in 1843, from which period until his own decease, in 1888, Mr. H. N. Slater conducted the business. He was succeeded by his stepson and nephew, Horatio Nelson Slater, who died Aug. 12, 1899. The woolen branch of the business, which had been conducted as a corporation under the name of Slater Woolen Company, was continued, and the cotton mill at the North Village and Cambric Mill, so-called, at the East Village, were continued by the executors of the estate. All of the manufacturing properties were consolidated under corporate management May 2, 1903, bearing the old firm name of S. Slater & Sons. The corporation completed a new weave-shed at the South Village woolen mill, and increased the capacity of the cotton mill at the North Village and of the converting mill at the East Village. At this latter plant a new mill was also built and equipped for the finishing of goods in "fast black." In October, 1908, the corporation acquired the machinery for the manufacture of worsteds formerly owned by the Excelsior Mills, at Farnumsville, and manufactures worsteds there under the name of Wuskanut Mills.

DARTMOUTH MANUFACTURING CORPORATION.

Dartmouth Manufacturing Corporation, of New Bedford, Bristol County, Massachusetts, with four mill buildings located on the Acushnet River and New York, New Haven and Hartford Railroad, was organized in 1895 by James W. Allen and Abbott P. Smith for the manufacture of fine cotton goods, and was duly incorporated under the laws of the Commonwealth of Massachusetts the same year. The capital stock of the corporation being fixed in the charter as $600,000, divided into 6,000 shares of one hundred dollars each. The first mill (No. 1) was erected in 1896, and was 821 feet long, 100 feet wide and two and three stories high, built of brick and equipped with Corliss and Harris steam engines. The 226,868 square feet of floor space in this mill building accommodated 27,000 ring spindles and 33,000 mule spindles, which 60,000 spindles supplied yarn to the 1,400 looms, also housed in the mill, producing fine cotton goods in plain and fancy weaves.

Rufus A. Soule was the first president of the mill, James W. Allen was treasurer and Walter H. Langshaw agent from the formation of the enterprise. The Board of Directors comprised Rufus A. Soule, Chas. E. Riley, Stephen A. Jenks, Abbott P. Smith, Thomas H. Knowles, Gilbert Allen, Thomas B. Tripp, Frederic Taber, Nath'l B. Kerr, Clarence A. Cook, Arnold Schaer and James W. Allen. Mr. Langshaw was elected a director of the corporation in 1898, succeeding Mr. Schaer. In December, 1900, the proposition made by Mr. Langshaw to build a new mill, doubling the capacity, was opposed by a majority of the directors. This brought about a controversy between Mr. Langshaw and President Soule, which resulted in a division of the board of four to five, and Mr. Langshaw was discharged as agent in June, 1901, notwithstanding his supporters represented the majority of stock. Two months later, at the annual meeting in August, a board of directors, comprised of Chas. E. Riley, Walter H. Langshaw, James W. Allen, Geo. S. Homer, John Duff, A. Martin Pierce and Stephen A. Jenks, was elected, and the members of the old board, who had been opposed to building a new mill, were defeated. At a meeting of the directors, after the annual meeting of the stockholders, Chas. E. Riley was elected President and Mr. Langshaw was reinstated as agent. Work was begun on plans for a new mill, and in October of the same year the plans were approved and contracts made for buildings necessary to double the capacity of the plant.

One of the new buildings was a weave shed 804 feet long by 200 feet wide. The capital stock was not increased, but twenty-year bonds were issued for $500,000, carrying interest at the rate of four per cent. On the completion of new mill, Mr. Hatton Langshaw was appointed superintendent.

In February, 1906, a difference of opinion arose between President Riley and Agent Langshaw, the two largest owners in the corporation, as to the future policy of the concern which brought about a contest for the control of the stock, which resulted in Mr. Langshaw and his associates securing the control of the stock and in the election of a board comprising Walter H. Langshaw, James W. Allen, George S. Homer, John Duff, Lloyd S. Swain, Stephen A. Jenks and Leroy Fales, the latter being elected in the place of Mr. Riley. At a subsequent meeting of the directors, Mr. Langshaw was elected president. During the contest, a voting trust was formed pooling a majority of the stock for a period of ten (10) years, and Messrs. Thomas H. Knowles and Oliver F. Brown were appointed trustees.

During the year 1906 a new two-story building was completed, in which there were installed about a thousand looms, and in 1911 the plant consisted of five buildings—a five-story cotton house and four buildings used for manufacturing purposes, and during the period from 1906 to 1911 the mill increased from 60,000 spindles and 1,500 looms to 200,000

spindles and 5,700 looms, containing 59,400 ring and 67,200 mule spindles and 4,150 looms, manufacturing plain, jacquard and fancy cotton fabrics and novelties comprised of cotton and silk.

DWIGHT MANUFACTURING CO.

Dwight Manufacturing Company, located at Chicopee, Hampden County, Mass., on the Chicopee River and Boston & Maine Railroad, was organized by Thomas M. Perkins, William Sturgis and Edmund Dwight, "for the purpose of manufacturing cotton goods." The business was incorporated under the laws of the Commonwealth of Massachusetts, Feb. 6, 1841, as the Dwight Manufacturing Company, with a capital stock of $500,000. Samuel Cabot was the first president of the corporation, serving 1841-59; James G. Mills served as the first treasurer, 1841-53, and William F. Otis as the first clerk of the corporation, 1841-45. In 1844 the capital stock of the corporation was increased to $700,000. The original mill, erected at Chicopee in 1841, housed 10,000 spindles, the mills and their capacity being increased as the capital stock was enlarged. In 1845 N. H. Henchman succeeded William F. Otis as clerk of the corporation, and in 1853 F. H. Story succeeded James G. Mills as treasurer, serving 1853-66.

In 1856 the corporation, in order to absorb the Perkins Mills, which, in 1852, had consolidated with the Cabot Manufacturing Company, was privileged by the legislature of Massachusetts to increase the capital stock to $1,700,000. In 1859 Thomas J. Allen was elected clerk of the corporation, serving 1859-87. Ignatius Sargent succeeded Samuel Cabot as president in 1859, and served until 1861, when he was succeeded by William Amory, who served five years.

In 1866 John A. Burnham was elected president, which office he held until 1876, his successor being T. Jefferson Coolidge, who served from 1876 to 1892, when he was temporarily succeeded by Mr. Amory A. Lawrence. Mr. Coolidge was again elected president in 1893, serving until July 10, 1905, when Mr. J. Howard Nichols became president. Upon the death of Mr. Nichols, Sept. 15, 1905, Mr. Coolidge was once more elected to the office, and served until Oct. 15, 1909, when he resigned and Mr. Theophilus Parsons became president.

In 1866 Daniel N. Spooner was elected to succeed Mr. F. H. Story as treasurer, and he remained in that office from 1866 to 1870, when Charles W. Freeland was elected, serving from 1870 to 1876, his successor being J. Howard Nichols, who was treasurer up to July 10, 1905, when he resigned to become president. July 10, 1905, Mr. Edwin Farnham

Greene succeeded Mr. Nichols as treasurer, and served until Dec. 11, 1907, when he resigned to assume the treasurership of the Pacific Mills. Mr. Greene was succeeded, Dec. 11, 1907, by Mr. Ernest Lovering.

In 1866 the capital stock of the Dwight Mfg. Co. was decreased to $1,500,000, and in 1870 to $750,000; but in 1872 it was increased to $1,200,000, and in 1894 an increase to $1,800,000 was authorized, though additional stock had not been issued up to 1910.

In 1894 the charter was amended so as to authorize the corporation to "manufacture cotton and woolen goods in any part of the United States," and in 1896 the first mill owned by the corporation in Alabama was erected at Alabama City, Etowah County, of which R. A. Mitchell was made agent and C. H. Moody superintendent, the mill being equipped with 30,000 ring spindles and 1,000 thirty-six-inch and forty-inch looms for manufacturing sheetings and drills by steam power. This was supplemented by Mill No. 2 in 1898, increasing spindles to 60,000 and looms to 1,916. In 1901 spindles were increased to 62,000 and looms to 2,000.

The establishment of the Dwight Manufacturing Company in Alabama City transformed that section from an almost unsettled community into a progressive village or town, with a population composed principally of the employees of the Dwight Mfg. Co. Great attention was given to the welfare of these employees. The company built an immense number of attractive cottages to be rented by operatives at the rate of from $3 to $5 per month, every house being of a varied style and color, giving an individual appearance to each home. The work-rooms of the mills are spacious, high-studded, light and well-ventilated, cooled in the summer by cold air and warmed in the winter by heated air, blown in by the ventilating system. In each room free ice water is supplied to all operatives during the entire year. The company also benefited its employees by the erection of a two-story brick building, the second story of which is furnished for the use of the Masons, Odd Fellows, Knights of Pythias, Red Men Juniors and other fraternal organizations. Mr. Nichols erected at Alabama City, in memory of his son, Howard Gardner, who had charge of the erection of the mills in Alabama, a public library building, the first in the State of Alabama, also a fine church and schoolhouse for the use of the inhabitants of the village.

The equipment of the mills at Chicopee in 1910 included 165,000 spindles and 4,000 looms, engaged in the manufacture of sheetings, shirtings and dress goods. The number of spindles operated by the corporation in 1910 totaled 227,000, and looms 60,000. To operate this machinery requires steam engines and turbines and water wheels aggregating 10,000 horse-power.

In 1910 the officers of the company were as follows: Theophilus Parsons, president; Ernest Lovering, treasurer; George H. Nutting, clerk of the corporation; Louis A. Aumann, agent at Chicopee, Mass.; M. O.

ARLINGTON MILLS.

LAWRENCE. MASS.

Dean, superintendent at Chicopee, Mass.; C. H. Moody, agent at Alabama City, Ala.; Irving Southworth, superintendent at Alabama City, Ala., and Messrs. Minot, Hooper & Co., of New York City, were selling agents for the entire plant.

ARLINGTON MILLS.

The Arlington Mills are located on the Spicket River, in Lawrence and Methuen, Essex County, Mass., on the Boston and Maine Railroad. A factory for the manufacture of woolens was built in 1865 by Robert M. Bailey and Joseph Nickerson, who, together with Chas. A. Lombard and George C. Bosson, were the original proprietors. Within a very short time the owners purchased the piano-case factory of Abiel Stevens on the Spicket River, and in 1865 a corporation was formed under the style of the Arlington Woolen Mills, Robert M. Bailey being elected first president. The manufacture of fancy shirting fabrics, flannels and woolen-felted goods had been carried on about two years, when the entire plant was destroyed by fire. The capital stock, which at first was only $150,000, was increased to $200,000, and a new mill was erected on the ruins of the old piano-case mills and completed early in 1867. Under the stimulus given by the tariff of 1866 to the manufacture of worsted goods, the company diverted the 175 looms and other worsted machinery with which it was equipped to the production of women's worsted and cotton-warp dress goods. The corporation, however, did not prosper, and it was twice reorganized. In 1867 William Whitman was elected treasurer, but he found the conditions so unsatisfactory that in 1869 he resigned, but before the end of the year he was re-elected, and a determined effort was then put forth to place the corporation on a more solid financial basis, and at the same time extend the property. The capital stock was again increased, this time to $240,000. In 1870 a reorganization was effected which made Joseph Nickerson president and William Whitman treasurer and general manager of the mills, and at the same time the stockholders paid in the whole amount of the authorized capital. The expansion of the business under this supervision was phenomenal and without a parallel in the history of manufacturing in New England. In 1871 the mill was remodeled and its productive capacity increased. In 1872 the company began the manufacture of alpacas, mohairs and brilliantines, which immediately took rank with those made in Bradford, England, and in 1875 the corporation name of Arlington Mills was adopted. The capital stock was constantly increased; in 1877 to $500,000; in 1880 to $750,000; in 1882 to $1,000,000; in 1887 to $1,500,000; in 1890 to $2,000,000, and in 1896 to $2,500,000. Mill after mill was added, until, in 1911, the

buildings comprised more than sixty acres of floor space and the capital stock was $8,000,000.

The Arlington Mills began the manufacture of dress goods nearly fifty years ago, and during this half century has always maintained a high standard of perfection and has manufactured the best worsted dress fabrics for women's wear made in this country. This branch of the business has steadily grown from 1865 to the present time, and it now requires 2,500 looms to take care of the demands of the trade. These goods are sold to the jobbing trade and the cutting-up trade throughout the country.

The staples in which the Arlington Mills specialize are brilliantines, Sicilians, mohairs, imperial serges, storm serges, cheviots, Panamas, batistes, taffetas, voiles, nun's veilings, cashmeres, shepherd checks, etc.

The spinning capacity of the Arlington Mills is far beyond the requirements of the looms, and many years ago it began the production of worsted yarns for sale. In this way manufacturers of limited capital were encouraged to build up new weaving enterprises without the expense of building and conducting large spinning plants. The output of the worsted spinning mill in 1910 amounted to 275,000 pounds of worsted yarn per week. Step by step the successful manufacture of worsted yarns has been developed along with the manufacture of dress goods, an enormous quantity of these yarns being required to keep running the looms of a large number of mills throughout the country, for the yarns that are thus sold enter into almost every kind of worsted cloth, and their standard is the highest of any made in the United States.

In 1881 the Arlington Mills introduced the spinning of cotton yarns in order to supply specially prepared warps for some classes of its dress goods. A four-story spinning mill and two-story twisting mill were erected at that time, but additions have been gradually made to this department, and the sale of cotton yarns to other manufacturers has become a large and important part of the business. To meet this rapid growth, two large new mills were added in 1903, in which a splendidly equipped mercerizing plant was installed and also a dye-house, in order to provide the trade with colored as well as gray yarns. The best quality of cotton yarns are turned out in this mill for knitters and weavers of all kinds of fabrics—gray, gassed, mercerized and dyed yarns—put up in every form required by the trade. The reputation of the Arlington Mills as regards this particular feature is, thus far, second to none in the country. This department in 1910 comprised four large buildings with a floor space covering more than eight acres wholly devoted to the manufacture of cotton yarn.

In 1896 the construction of a worsted top mill devoted to carding and combing wool for spinning added to the output of the Arlington Mills and enabled spinners to obtain partially prepared raw material with-

out the expense of building mills for that purpose. In connection with this department, a large plant has also been built for removing the grease from wool by the use of naphtha, which greatly improves the quality of the product. The Top Mill at this writing has a capacity for handling 1,250,000 pounds of greasy wool per week.

The Arlington Mills corporation had as successive presidents: Robert M. Bailey, 1865-1870; Joseph Nickerson, 1870-80; Albert Winslow Nickerson, 1880-93; George Augustus Nickerson, 1893-1902. In 1902 William Whitman, who for thirty-five years had served the corporation as treasurer, was made president. Franklin W. Hobbs was at this time elected to the treasurership, and has, during his nine years of service (1911), proven himself an efficient successor to Mr. Whitman. Mr. Hobbs was also executive officer of the mills. In 1902 the capital stock of the corporation was increased to $3,000,000; in 1905, to $5,000,000; in 1908, tc $6,000,000, and in 1910, to $8,000,000.

In 1911 the officers of the corporation were: Directors, George E. Bullard, Livingston Cushing, Robert H. Gardiner, Franklin W. Hobbs, James R. Hooper, George E. Kunhardt, Charles W. Leonard, William K. Richardson, Richard S. Russell, George M. Whitin and William Whitman; president, William Whitman; treasurer, Franklin W. Hobbs; resident agent, William D. Hartshorne; transfer agent, The New England Trust Co. The executive offices of the corporation were located at 78 Chauncy Street, Boston, Mass.

The equipment of the mills in 1911 included 138 worsted cards, 92 worsted combs, 120,804 worsted spinning spindles, 2,400 worsted dress goods looms and 62,268 cotton spinning spindles. The number of employees needed to keep this vast amount of machinery running at its maximum capacity was 8,900, with a weekly pay-roll of $77,000. Largely through the growth of the Arlington Mills, Lawrence became the largest wool manufacturing city in the United States.

The mills are all heated and ventilated with scientific thoroughness by the most approved methods. The health and comfort of the operatives are most carefully looked after, both because these precautions are the rightful due of the working people and because enlightened self-interest to-day has shown that they are essential to the highest efficiency. The Arlington Mills in 1877 adopted the policy of weekly payment of wages, and was the first corporation of any importance in Massachusetts to adopt the progressive and helpful policy which eight years later was made compulsory by law in all manufacturing establishments in Massachusetts. In this and every other line the Arlington Mills has at all times led in every effort to improve the conditions of labor in the textile mills of New England.

SANFORD MILLS.

This enterprise, which has transformed the farming village of Sanford, Me., into an important commercial and industrial centre, had its inception in 1867, when Thomas Goodall came to Sanford from Troy, N. Y.—where he had been engaged in the manufacture of horse and army blankets—and purchased William Miller's flannel mill, James O. Clark's grist and sawmills and the entire water power of the Mousam River controlled by these manufacturers at that point.

Mr. Goodall immediately began the enlargement of the plant, and early in 1868 had two sets of cards and ten looms in operation, giving employment to fifty operatives in the production of kersey blankets and carriage robes, the first of their kind manufactured in the United States. The ever-increasing demand for these commodities necessitated larger facilities for their production, and the mills have now (1911) grown to a capitalization of $1,250,000 and the employment of two thousand operatives. L. C. Chase & Co., of Boston, Mass., are the selling agents.

In 1873 Lucius C. Chase, of Boston; Louis B., George B. and Ernest M. Goodall, sons of Thomas Goodall, and Amos Garnsey, Jr., formed a co-partnership, and in 1874, under the style of Goodall & Garnsey, began the manufacture of plain and fancy blankets in newly erected factories known as the Mousam River Mills. Prior to 1882 all mohair plushes used in America were imported from Europe, principally from France. In that year George B. Goodall, of Sanford, Me., commenced experimenting on a wooden hand-loom of his own make, and it was he who wove the first piece of mohair plush made in America. Having proved to his satisfaction by further experimentation that mohair plush could be woven on a power loom, with his brothers, Louis B. and Ernest M., he organized a company for the purpose of entering upon its manufacture. This firm, known as Goodall Brothers, together with the Mousam River Mills, referred to above, was afterwards consolidated into the Sanford Mills. With the assistance of a talented inventor, the perfect-working, wire-motion, power plush loom, thereafter used in the mill, was produced and put into operation.

The company started with one loom, and from this small beginning steadily grew until they reached the eminence of standing at the head of the mohair plush manufactories of the world. In 1911 the Board of Directors of the corporation consisted of E. M. Goodall, G. B. Goodall, John Hopewell and Frank Hopewell. The officers comprised E. M. Goodall, president; E. E. Hussey, vice-president; Frank Hopewell, treasurer; Frank B. Hopewell, assistant treasurer; W. O. Emery, clerk; L. C. Chase & Co., of Boston, selling agents.

The following brief description of the Sanford Mills will give our

Sanford Mills, Sanford, Maine
Original Mill Built 1870

JAMES H LAMB Co

readers some idea of the magnitude of the plant operated by the Sanford Mills Company:

Mill No. 1 is the actual nucleus of all the Goodall enterprises; it is devoted to the carding, spinning and weaving of carriage robes and velours; is three stories high, 40 feet wide and 160 feet long, with a two-story ell 40 by 75 feet.

Mill No. 2 is a three-story structure with basement, 140 feet square. The carriage robe and velour finishing departments occupy the first and second floors of Mill No. 2, while the third floor is devoted to the drying and storing of imprinted fabrics.

In the winter of 1888-89, a roomy building was put up on the westerly side of the Mousam River, connected with mills 2 and 3 by grade and overhead bridges; and here the printing, chemical, block-making, color-making, steaming, washing, pile-raising and drying departments are conducted.

Mill No. 3 is a three-story building, 50 x 120 feet; the ground floor is devoted to the storage of raw material, the second floor to mixing the blends for making carriage robes, and the third contains the plush-stretching machinery and appliances for the drying of printed and imprinted fabrics.

Parallel with Mill No. 3, and connected with Mill No. 2 by an overhead bridge, is an immense building, the first floor of which is devoted to the storage of raw material, and the second and third floors to the storage of finished carriage robes and blankets; the packing and shipping departments are also under this roof.

Mill No. 4 occupies a position directly across the Mousam in an easterly direction from Mill No. 2. It is 60 x 600 feet, and on the ground floor are the fulling and pile or warp raising machines, also the mohair warping and combing departments; the mohair spinning departments occupy the second and third floors.

Mill No. 5, connected with Mill No. 4 by a covered bridge, is a weaving shed, 375 x 125 feet, with monitor roofs of glass, especially constructed with a view to perfect lighting. It contains an immense number of plush looms and affords space also for the drying, cropping, embossing, steaming and packing and shipping departments in connection with the production of car plushes.

Mills Nos. 6 and 7, formerly known as the Mousam River Mills, are 50 x 170 feet and 40 x 120 feet respectively. In the first are the carding, spinning, weaving, dyeing and finishing departments; in the second, the raw material undergoes the initial process towards conversion into blankets.

In a building situated south of Mill No. 5 a tinsmith manufactures the long wire knives used for loop-cutting in the plush looms and repairs the long tin cylinders used in the mohair spinning frames.. The plant

operates its own saw mills for the manufacture of shipping cases and for the preparation of lumber for buildings and all other purposes, and a large number of machinists and wood-workers are constantly employed in well-equipped shops, while the blacksmith's hammers are heard ringing from the anvils of their forges.

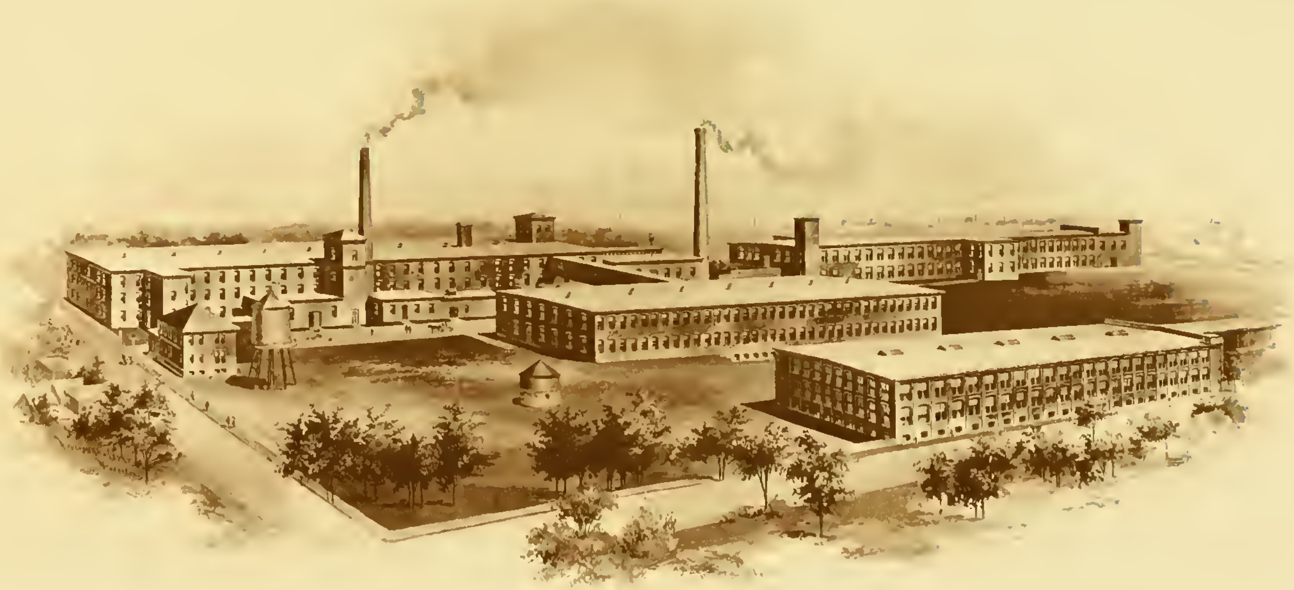
The factory yard includes many acres, and scattered about it are numerous buildings for the housing of raw material valued at hundreds of thousands of dollars.

Every factory is provided with the sprinkler system for protection from fire, the same being connected with huge reservoirs.. The Sanford Mills have also a thoroughly equipped fire department, including an Amoskeag steamer, hose trucks and combination hook and ladder apparatus, handled by expert firemen. An automatic force pump, operated by steam, with a capacity of 1,200 gallons of water per minute, is set up in a brick building, situated at a very considerable distance from any other building. The yielding of a single fusible plug, in any part of the sprinkler system, suffices to set this pump in motion. The motive power is supplied by water, steam and electricity, the total amount of 1,500 horse-power being used to operate the plant.

SHAW STOCKING COMPANY

The Shaw Stocking Company, Lowell, Middlesex County, Mass., is located on the Merrimack River, and railroad facilities are afforded by the Boston and Maine Railway system. The enterprise was promoted by Benjamin F. Shaw, E. A. Thissell, Jacob H. Sawyer and others, the object of the promoters being to further increase the facilities for manufacturing in Lowell. The promoters obtained a charter of incorporation from the legislature of the Commonwealth of Massachusetts, Oct. 16, 1877, as the Shaw Stocking Company, with a capital stock of $30,000.

The first mill was two small rented rooms in which were operated a few Shaw knitting machines. As the business increased, Mill No. 1 was built, 238 feet long and 40 feet wide, three stories in height. The business, which consisted of the weaving of hosiery, prospered, and soon it became necessary to enlarge the plant. Mill No. 2 was then built, 251 feet long and 75 feet wide, with two stories over a high basement; and, subsequently, Mill No. 3, 235 feet long, 74 feet wide, two stories high. These were followed by Mill No.4, 245 feet long, 118 feet wide, with two stories and a storage basement, which was devoted exclusively to carding and spinning cotton yarns. In the latter were installed 12,432 modern spindles, making the finest quality of combed yarns for use in the company's production of "Shawnit" hosiery. The capital stock was increased from time



Shaw Stocking Company

Lowell, Mass

JAMES H LAMB CO

to time until, in 1911, it was placed at $540,000. The 700 Shaw looms and 12,432 spindles produced Shawknit men's half hose and children's long stockings, woven from cotton, merino, wool, worsted, lisle and linen yarns, the goods being of various weights from heavy to gauze.

In 1911, Mill No. 1 was used by the box-making and printing department, and by a dyeing and oxydizing department. To Mill No. 1 was attached the engine and dynamo-rooms and the boiler-house. Mill No. 2 was devoted to finishing, to storage, packing and shipping, and to machine and carpenter shops. The four large mill buildings were in 1911 furnished with heat and power from Corliss, Rollins and McIntosh and Seymour steam engines, and the corporation owned its own dynamo and electric lighting plant, as well as its own water plant. The establishment gave employment to 600 men and women as operatives and helpers in the various processes of manipulating the raw cotton as it reached the mills in bales into finished stockings boxed and cased ready to be sent to the jobber, the retailer or the wearer. On June 1, 1910, the officers were: Frank J. Dutcher, William E. Hall, E. A. Thissell, Frank E. Dunbar, George S. Motley, Amasa Pratt, Josiah Butler and Edward W. Thomas, directors, with Frank J. Dutcher as president and William E. Hall as treasurer and general manager.

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Sketches and their location are indicated by the heavier type and figures